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Multiple Lightning Flashes.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

PERHAPS some of my readers who have attentively watched lightning flashes during a violent storm have been led to the conclusion that some brilliant flashes have been observed to distinctly *quiver* as they traversed the space between the clouds and the earth.

In my experience such a flickering of a flash has often been noticed, and I have on many occasions been led to think that the cloud was simply pouring down electricity along the same track to the earth, or, as it may be described in other words, the lightning seemed to stream from the cloud as water from the nozzle of a fire hose, so comparatively long did the flickering flash appear to last.

I think that on these occasions we are really dealing with several flashes pursuing the same path to earth, although the total duration of the several discharges occupies only a very short interval of time.

Mr. Shelford Bidwell some years ago suggested that this phenomenon is sometimes a purely subjective one, due, as he has stated, to a certain physiological reaction of the optic nerve. To illustrate this effect he proposed that one should gaze at a bright object which is suddenly and immediately extinguished; then, after a very short interval of darkness, a distinct but transient image of the flame will reappear. It is even possible that after another brief interval a second after-image of the flame may be seen.

It may not be without interest, therefore, to enter somewhat in detail into the nature of "multiple" flashes and to place before the reader in the first instance two or three accounts which have been published relating to the *observation* of flashes which appeared to flicker or quiver, but which were most probably instances of "multiple" lightning.

Mr. H. J. Staples, who closely observed flashes during a thunderstorm (*Nature*, vol. 18, p. 67, 1878), noticed "that several of the brighter flashes were preceded by one or sometimes two smaller flashes, the large flash following immediately after and taking the same course as the smaller ones."

That the occurrence of multiple flashes is by no means rare, even to the eye, will be gathered from the following observations of Mr. E. H. Pringle (*Nature*, vol. 18, p. 587, 1878). In his description dated October 1, 1878, he says:—

"In almost every tropical thunderstorm the phenomena may be seen to best advantage when the storm is distant. Three, four, and even more discharges may take place, the second and remaining flashes following in rapid succession through the identical path taken by the first. The intervals between the flashes vary; one may follow another so rapidly as to seem merely like a bright pulsation in the first, or there may be an appreciable interval of darkness; but it is certain that, if the eye can be trusted, these secondary flashes follow the exact course of their primary. The reason of this may be looked for in the heating effect of the lightning. The partial vacuum caused by the first discharge offers a line of comparatively small resistance to the succeeding currents.

"The singular part of the phenomenon is the rapidity with which the electricity must form or collect to admit of several discharges taking place at the same spot, for I do not think the secondary flashes can be regarded as merely residual."

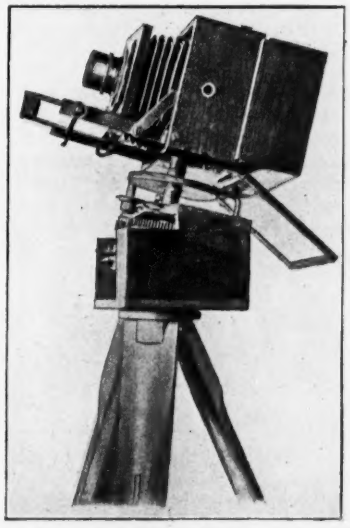


Fig. 1.—Camera, with clockwork arrangement underneath, as used by Dr. Walter, of Hamburg, for photographing multiple lightning flashes.

Perhaps the most remarkable observation of long continued "multiple" flashes is that which was communicated by Mr. R. Godlinton, of Buluwayo, to the Royal Society of London and vouched for by three witnesses. This account, which was printed in *Nature* (vol. 53, p. 272, 1896), was as follows:—

"I think it may interest you to know that an extraordinary flash of lightning was witnessed from this place this evening at 7.38 p.m. It has been raining in torrents nearly all day long; the heavens seem heavy and saturated with rain, but we have had no thunder at all.

"Now the undersigned were seated round a table in a room in Fife Street, and only one of us had his eyes turned in the direction of the door, which was open. Suddenly he exclaimed, 'Good Heavens! just look at that lightning, it's standing still!'

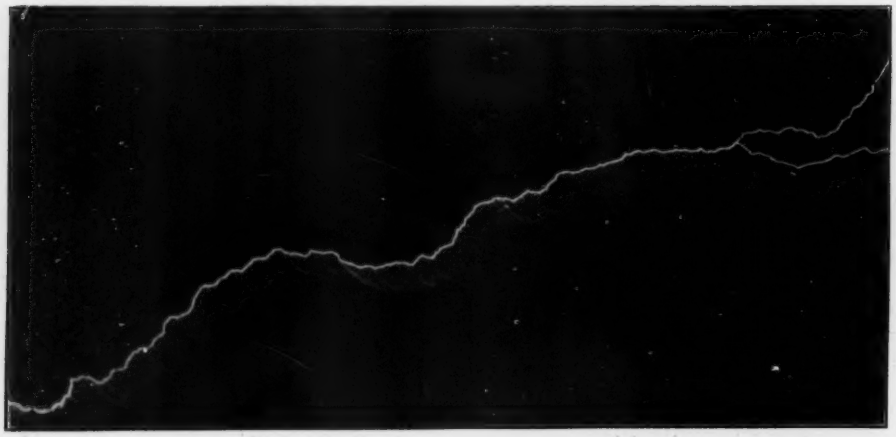


Fig. 2.—Trail of a lightning flash on a photographic plate due to the incandescence of the air. Camera moved by hand. April 12, 1904, 9.40 p.m., Paris.1 Photographed by M. Emile Touchet.

"All of us promptly went to the door, whence we witnessed a truly extraordinary sight in the shape of three ribbons of a greenish-white lightning, which hung in the sky, motionless, for what must have been fifteen to twenty seconds. It seemed to be a long way off (in a north-westerly direction), as we heard no report of thunder whatever. We put some questions to our Makalaka boy, who said that he had never seen anything like it in all his life.

"There could be no mistake about it—it was as distinct as possible, and it must have lasted fifteen seconds *at least* (I should say twenty myself). . . ."

The above instances are among many that could be quoted, but these may, perhaps, be sufficient to indicate that some flashes are composite or multiple in their nature, and appear different to an ordinary "single" flash of lightning.

The question now arises, Can the camera help us to investigate the nature of these flickering or multiple flashes? Can it be proved that what *appear* to be single flashes are really composed of several individual flashes following in the same track? Yes, I think it can, and in a very easy manner, so easy, in fact, that we are in possession of a great number of photographs which prove that "multiple" flashes are of far more common occurrence than was at first anticipated.

Every photographer knows that it is impossible to obtain a satisfactory photograph of an object at rest if he holds the camera in his hand and gives a time exposure. The reason of this is that during the exposure it is impossible, or, at any rate, exceedingly difficult, to keep a camera perfectly still, and, consequently, during this interval the image of each portion of the object is moving about, and therefore forming a trail, on the photographic plate, the trail corresponding to the particular motion of the camera.

Now, by adopting the method of moving a camera while it is being employed for photographing a flash it is quite a simple matter to obtain records of the components of multiple flashes. Though it might be impossible to move the instrument appreciably in the exceedingly brief interval of a *single* lightning flash, yet if several flashes do pass in quick succession over the same path, they will appear as separate images side by side on the plate by moving the camera during their occurrence. The fact is that there is quite, comparatively speaking, a long interval between some of these successive flashes, and even a not very rapid motion of the camera easily separates the components.

Let us in the first instance decide how the camera should best be moved, and, after that, consider what we should expect to find on the plate after a flash had been photographed. The reader is no doubt aware that the majority of lightning flashes pass between the clouds and earth, and, therefore, the flashes are more or less vertical. To separate the components of "multiple" flashes the camera should, therefore, be moved in a horizontal direction; that is, in a direction at right angles to the length of the electric discharge.

With regard to the movement of the camera, there are several devices that may be adopted. The first and most simple method is to hold the camera in the hand and oscillate it in a horizontal direction about a vertical axis with either the centre of the camera or the lens in this axis. The rate of oscillation need not be excessive, one to and fro movement in a second being quite sufficient to demonstrate clearly the multiplicity of flashes. This hand movement is naturally the most common, since it requires no extra apparatus, and can, therefore, be used at a moment's notice. Further, it has another distinct advantage, because the camera can always be kept pointing roughly in the direction in which the

Fig. 3.—A single flash photographed with a camera having an elliptical motion. Taken on July 2, 1889, by Prof. L. Weber.

flashes appear to occur most frequently, and, therefore, there is a much greater chance of catching a flash.

A simple device which has often been used is to mount the camera on the end of a wooden lath and swing the lath as a pendulum.

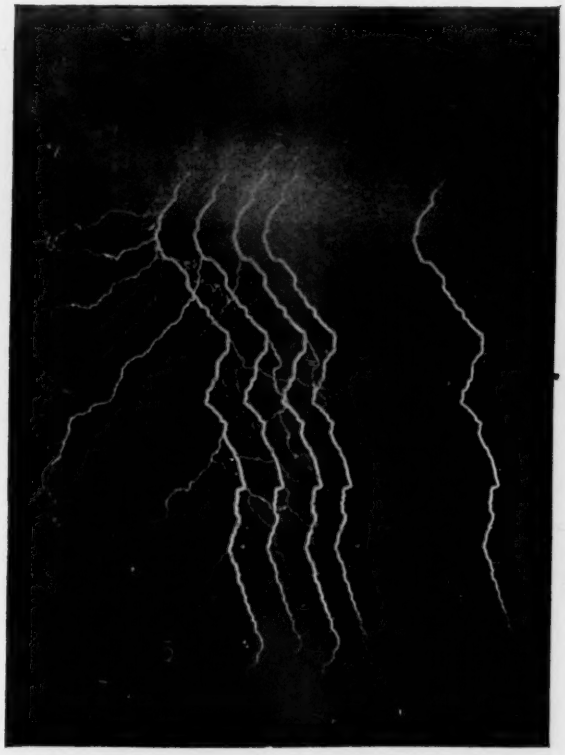


Fig. 4.—A "quintuple" flash with ramifications, photographed at Hamburg on May 30, 1902, by Dr. B. Walter.

Some photographers have gone to the trouble of employing a special camera in which the lens is made to rotate in front of a fixed plate, while others have moved the film or plate in relation to the camera objective.

If the reader wishes, however, to take up the subject in real earnest he cannot do better than adopt the principle employed by Dr. B. Walter, of Hamburg. A description of his method is given in volume 20 of the Year-book of the Hamburg Scientific Institution, 1903, and is entitled "Uber die Entstehungsweise des Blitzes," and it is further enriched with a set of excellent and instructive reproductions from his lightning negatives.

Dr. Walter fixes to the bottom of his camera (Fig. 1) a short hollow axis with a wooden disc fitted to the outside. This wooden disc is made to rest on another wooden disc of the same size, the solid axis of which passes into the hollow axis of the first-mentioned disc. The camera in this manner can be rotated with respect to the lower solid axis, the only resistance to be overcome being that of the friction between the surfaces of the discs. Now, the lower axis is operated by clockwork, and the speed of rotation can be accelerated or retarded at will. By starting the clockwork the camera is made to complete a series of rotations, but in order that no time should be wasted by the camera pointing in directions in which the lightning flashes are not occurring, the operator stands by the instrument and intermittently pushes back the camera in the opposite direction to which it is moving. Thus the lens is made to continually sweep the desired field of view at either a slow or fast speed as is required. That the method employed is very efficient is demonstrated by the fine series of photographs which Dr. Walter has succeeded in taking.

It may be mentioned that the attention of the operator at the camera could easily be dispensed with if a simple automatic arrangement be adopted to allow the camera to slide back as soon as a given arc had been described. The motive power to make the camera return would simply be a small weight suspended over a pulley by a string attached to the camera base, while the movement of release might be worked by the use of a cam.

One great advantage of using an apparatus of this kind is that the direction of movement and speed of the camera can be easily determined, and, consequently, the interval of time between the separate components of a multiple flash computed. When an instrument is held in the hand very little is known about the actual motion of the camera, as it is extremely difficult either to move the camera in one plane or to keep up a uniform oscillation.

Since the publication of Dr. Walter's interesting paper, a communication entitled "Photographing Lightning with a Moving Camera," has been published by Mr. Alex Larsen, of Chicago, in the Smithsonian Report for the year 1905 (page 119). This worker used a spring-motor movement (the kind used to operate revolving stands for exhibiting goods in show windows), and mounted it inside a table specially constructed for the purpose; a stand for supporting the camera was fitted to the central shaft. To increase the speed of the motor the fly-vane shaft was removed and the vane

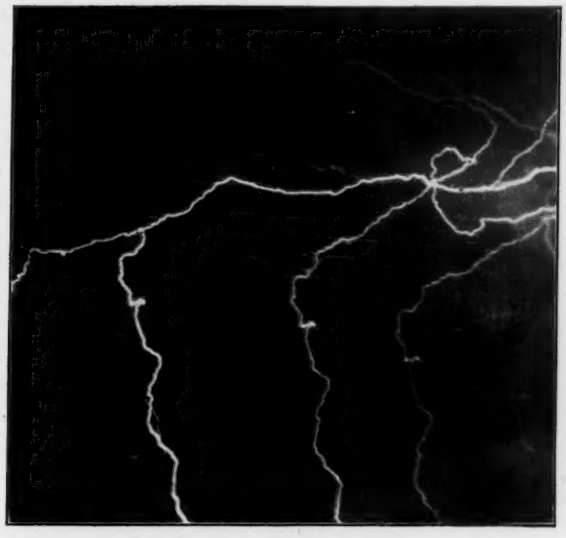


Fig. 5.—A "quadruple" flash, photographed in July 1902, by Mr. J. P. Wilkie.

moved to the next shaft, which was lengthened so as to extend under the table. The fly-vane was then made to revolve in a liquid placed in a vessel under the table; in this way much of the vibration was eliminated, and a

more uniform speed secured. The complete success of this device can be judged later on, when one of his photographs will be described and illustrated.

Having considered some methods of keeping the camera in motion, let us now turn to the second point and see what effect a moving camera should have in recording a *single* flash of lightning.

Now, although a *single* flash of lightning takes place in an exceedingly short interval of time, its energy is such that it raises to a very high temperature the column of air through which it passes. The result is that the air along its track is rendered incandescent, and, since it cannot cool instantaneously, it remains in this state for a brief interval of time after the actual electric discharge has subsided.

If, therefore, the camera be moved quickly, then the plate should show an image of the flash with bright streaks starting out from it and fading gradually away in a direction corresponding to the movement of the camera. The streaks should be most intense in those

Fig. 6.—Two "triple" flashes taken on June 6, 1889, by Dr. H. H. Hoffert.

parts of the flash which appear to lie in the direction of the camera's motion, and faintest when directed at right angles to this motion. The streaks are really the trails of the images of the incandescent air formed by the lens on the plate. The length of the trail on the photographic plate depends on the intensity of the original flash and on the speed of movement of the camera, so that the brighter the flash or the quicker the camera is moving the longer will be the trail. Of course, it is assumed that rapid plates are employed, because the after-glow is so much more faint than the initial discharge, and might not on this account be recorded.

A good example of a photograph taken with a camera moving somewhat obliquely is shown in the accompanying figure (Fig. 2). This illustration is a fine example of the trail of the "after-glow" following a single discharge, and was taken by Monsieur Emile Touchet, of Paris. It was secured during a storm which occurred on April 12, 1904, at 9h. 40m. in the evening, the camera being held in the hand and briskly moved obliquely. The reader will at once be able to distinguish the main flash, and he will notice also that the strongest trails behave in the manner described; that is, they are strongest where the curvature of the path of the discharge lies in the direction of the camera movement, namely, from left-hand top to right-hand bottom.

In the above paragraphs I have referred to the air as being rendered *incandescent* by the lightning flash, and this incandescence or after-glow lasting for some fractions of a second. Dr. H. H. Hoffert (*Physical Society*, June 1889, p. 108) as long ago as 1889 pointed out this effect, and described it as a "glow" or "a very considerable residual illumination." Monsieur Emile Touchet (*Comptes Rendus*, vol. 140, p. 1,030, 1905) quite recently referred to it as the incandescence of air particles. Herr K. E. F. Schmidt, on the other hand (*Elektrotechnische Zeitschrift*, vol. 26, p. 903, 1905), considers it as a kind of *phosphorescent* glow of the air particles.

Dr. Walter (*Annalen der Physik*, vol. 18, 1905) is disposed to consider it as being neither due to incandescence nor phosphorescence, but, as he calls it, a true *after-flow* of electricity ("Wirkliches Nachströmen von Electricität"), or after-discharges.

Some of his reasons against it being due either to phosphorescence or incandescence are that it is not observed in artificial sparks; that some strong flashes show no after-glow, while some weak ones indicate it strongly; that the streaks would diminish in intensity from the main flash, and not vary irregularly in intensity as is often the case; and lastly, that the streaks are not always continuous, but begin some small interval after the main flash. Without entering here into a discussion as to the validity of these reasons, I think the evidence of a great number of photographs shows that we are sometimes here probably in the presence of *both* incandescent air and weak after-discharges.

It is as well, however, to draw the reader's attention to the important part played by the *motion* of the camera, because if the speed be unequal then subsidiary intensification in lines parallel to the flash will most probably occur and give an appearance of fainter parallel flashes. This explanation may possibly account for the brighter streaks parallel to the main flash in some of the photographs obtained.

Further, the condition of the air through which the flash has passed may play an important part in either preventing or helping the production of the after-glow, and this may possibly be a reason for the absence of glow in some brilliant flashes, and its conspicuousness in comparatively weak flashes which have been photographed.

Which is the most correct term to use does not, however, concern us here, so long as the reader is made acquainted with the fact that some single flashes photographed with a moving camera leave a *trail* on the photographic plate.

It has been stated in a previous paragraph that when a bright object is photographed with a moving camera the trail on the plate corresponds to the particular kind of motion which is given to the camera. If the camera be moved in a straight line the trail will be straight, or if moved in a circle or an ellipse the trail will be circular or elliptical. In interpreting such photographs it is as well, if possible, to become familiar with trails obtained from *known* movements of the camera, since some photographs exhibit extraordinary markings which, as will be shown later on, have been explained as due to the peculiarity of the lightning flash itself.

XUM

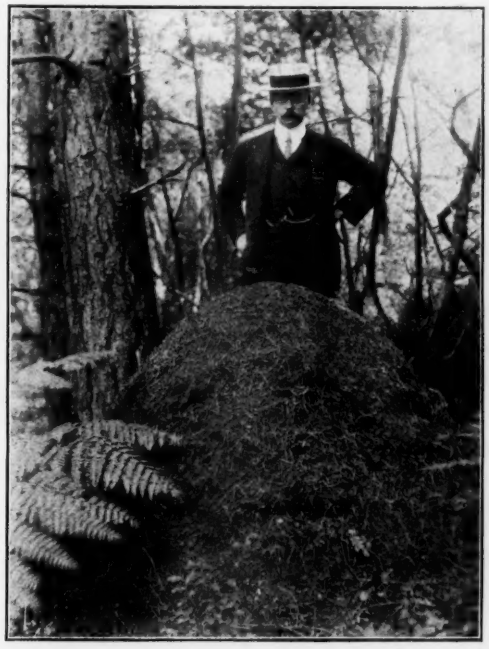
To show the kind of trail which can be produced when photographing a lightning flash by moving a camera with an elliptical motion, the accompanying illustration (Fig. 3) is given. The photograph is that of a single flash, and was taken by Professor L. Weber in Breslau on July 2, 1889, at 2 o'clock a.m. In his description of this photograph (*Sitzungsber. d. K. Preuss. Ak. d. Wiss. zu Berlin*, vol. 38, p. 781, 1889) he tells us that it took about one-third of a second to make the loop, so that the flash with its after-glow lasted for about half a second. We see here that the bright edges to the band do not represent different flashes, but are due to the change of direction of motion of the camera, thus allowing the after-glow more time to impress itself on those portions of the plate.

It should be mentioned that Professor Weber employed no apparatus to direct the motion of the camera, but held it in his hand, and this probably accounts for the form of the trail being more like the figure six than a complete ellipse. The photograph is, nevertheless, very instructive, and shows what may be expected when such movements of the camera occur.

(*To be continued.*)

A Large Ant-hill.

MRS. A. M. GOSSAGE sends us the accompanying photograph, which is of an extremely large ant-hill, to be



found in the woods about Crockham Hill, Surrey. The ants are the large black wood ants, and the nest is built of pine needles.

We have received from MESSRS. NEWTON AND CO. a copy of a new edition of their "Descriptive Lectures on the Science of Astronomy," which has been prepared to accompany the series of lantern slides published by that firm. We commend this little book to the notice of those organising entertainments for winter evenings, as such lectures are bound to interest and instruct all hearers.

Practical Aerodynamics and the Theory of Aeroplanes.

By MAJOR B. BADEN-POWELL.

VIII.—LANGLEY'S LAW.

I HAVE already referred to the fact that if a falling plane be driven at the same time in a horizontal direction it will fall more slowly than if simply descending vertically. Also that this action is equivalent to a plane progressing through the air at a slight inclination.

This effect, although easily accounted for when known, was never quite understood until investigated by Langley, and it forms the basis of what is now known as "Langley's law." This is defined by Chanute as follows:—"The weight remaining the same, the force requisite to sustain inclined planes in horizontal motion diminishes instead of increasing when the velocity is augmented."

This law has often been misconstrued, and may not at first be easy to comprehend. Even the originator himself states that it has a "paradoxical" appearance. When he says that "the power required to maintain the horizontal motion of an inclined aëroplane is less for high speeds than for low ones," it must be remembered that this refers to soaring speeds—the speed at which the weight of the apparatus will be borne on the air. If a plane of given weight and area be set at a fixed angle of inclination and driven horizontally at such a rate that it is supported, it will absorb a certain force. If the speed be increased, of course, the force will also have to be increased; this, however, gives a greater lift; but a greater lift is not required, and, therefore, either the area presented or the angle of inclination can be reduced, and yet the weight of the apparatus be upheld. By reducing either of these the forward resistance is reduced, hence also the requisite power. Therefore, with less expenditure of power the aëroplane is upheld at a greater speed.

Or, to put it another way, if two planes, A and B, of the same area, weight, and shape, be taken, but A being inclined at a greater angle than B, it is evident that, if both be propelled at the same speed, A will

require a greater force; or, on the other hand, if equal forces be applied to drive the planes horizontally, B will progress much the faster, since it has less resistance to overcome. The dotted lines of air strata show that with A a larger volume of air has to be displaced.

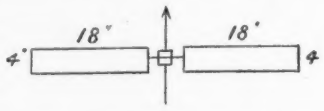
The same force, then, being applied, B will travel the faster. But at the smaller angle of inclination the upward thrust, or lift, will be greater in proportion to the drift (even at the same speed). Therefore, by decreasing the inclination and increasing the speed the same lift can be obtained with *less* power expended.

But the actual results obtained by Langley with his "Plane-Dropper" are really important. Not only do they show that the time of fall is greater as the horizontal velocity increases, but also "that this retardation goes on at an increasing rate with increasing

velocities." Then he proves that with "planes whose width from front to back is small in comparison with the length of the advancing edge" this effect is the more pronounced.

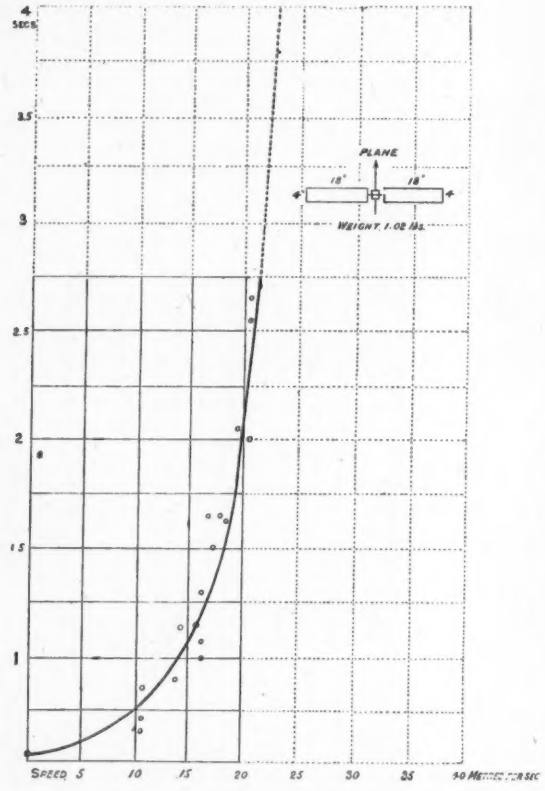
It seems a pity that he could not have tested this apparatus at greater speeds, for it looks as if we should then have obtained some very astonishing facts.

Take the results obtained with the widest plane shaped thus :—



The rate of fall at various speeds of translation is shown in the diagram; that is, the time in seconds which it took to fall through a height of four feet.

Langley only tested this up to a rate of 20.5 metres per second (about 45 miles an hour). By increasing the size of the diagram (as dotted lines) up to double the speed (and 90 miles an hour will probably not be an excessive speed for an aëroplane), we may realise the curious state of affairs resulting. Presuming the

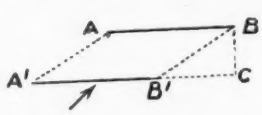


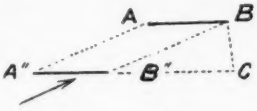
curve to be correctly plotted, it is very evident that at a speed of even 25 or 30 metres per second the rate of fall of such a plane will be almost indefinitely prolonged.

"We may reasonably infer," says Langley, "that with a sufficient horizontal velocity, the time of fall may be prolonged to any assigned extent, and that for an infinite velocity of translation the time of fall will be infinite." This means that a flat plane, weighing a pound per square foot, propelled horizontally at say 60 miles an hour, will continue in a horizontal course without falling!

One is inclined at first to consider that the friction of the falling piece against the frame might, to some extent, account for the slowness of fall at the higher speeds. But, the experimenter points out, with planes of other shapes, which should offer the same amount of friction, we do not get the same retardation of fall.

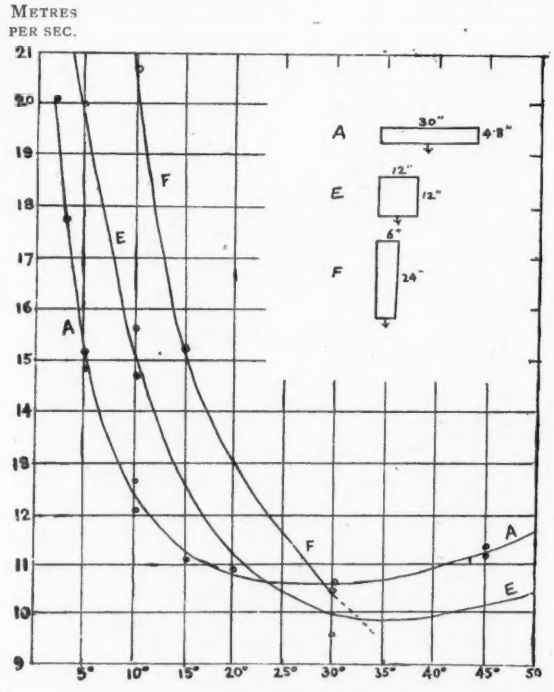
It may be seen that with a horizontal falling plane the increase of speed of progression is equivalent to diminution of angle of inclination in an inclined plane. This may be made clearer by diagrams.





We may, therefore, turn to Langley's experiments with his "Component Pressure Recorder" which gave the soaring speeds of planes at various angles of inclination.

The accompanying diagram shows the curves of the soaring speeds of three typical planes, each of them being one square foot in area, and weighing 500 grammes. A is moved with its long side foremost, and F with its short side.



Here we have a corroboration, to some extent, of the former results, for, with plane A (not quite so wide and short as that tested in the former experiment), we find that, as the angle of inclination is diminished, the soaring speed is very greatly increased. This would imply that with very much greater speeds soaring would be obtained with hardly any inclination. If the trace of E is more curved than that of F, and A still more curved than E, we must presume that the curve obtained by a plane 36 ins. by 4 ins. would be more pronounced still than the plane A, 30 ins. by 4.8 ins. Therefore, the

curve of such a plane would tend to meet the vertical line of 0° much higher up—if at all.

Whilst we have this diagram before us several interesting facts may be pointed out.

A wide plane like A does not soar at speeds under 10½ metres per second, while a square E soars at under 10, and the narrow plane F would apparently soar at a much lower speed.

It is noticeable how, with a plane like A, at inclinations between 15° and 45°, there is very little difference in the speed necessary to cause it to soar; that is to say, at speeds of about 10½ to 11 metres per sec. it will soar whether the angle be 15° or 40°. With the long and narrow F, on the other hand, each degree of inclination calls for a different speed.

Some Rarer Agents of Pollination.

By G. Clarke Nuttall, B.Sc.

The cross-fertilisation of flowers is commonly said to be brought about either by the wind, as in the pines and hazels, or by insects, as in lilies, jessamine, and orchids. And of insects, bees, moths, and various kinds of flies are those which gain all the credit in the popular mind of being beneficial flower visitors. Though this assumption is justified to a great extent, inasmuch as these two agents account for the large majority of cross-fertilisations effected in the flower world, yet there is an important minority of plants which depend on outside agents other than these to give that magic touch which alone can call posterity into being, and the consideration of these rarer agents of pollination is one which brings forward various points of interest in the interaction between the plant and animal worlds.

For instance, the fact that certain plants rely for the fertilisation of their flowers upon bats has only been recognised within the last few years, and our knowledge upon this point is certainly not yet fully exploited. In the Royal Botanic Gardens at Trinidad the work of bats in this respect has, however, come under direct observation. A certain tree known as Bauhinia megalandra, which grows to the height of about thirty feet, produces in January each year long white flowers which first appear in the later part of the afternoon and gleam out in their full glory in the dusk. About half-past five, when the dusk begins to deepen into darkness, the bats come out of their day hiding-places and fly swiftly hither and thither. The white gleaming Bauhinia tree specially attracts them, and they quickly pounce on the flowers one after another to the great injury of their beauty. For a bat, when it settles on a flower, secures itself by seizing on the white petals whose delicate fabric cannot withstand the rough onslaught, so fragment after fragment flutters to the ground as the bat struggles for foothold. The stamens, too, show traces of rough usage, and are sometimes torn right away and follow the petal fragments, but the stigmas in the centre of the flower remain for the most part unharmed. One would naturally imagine that the bats found nectar in these flowers as their visits are so eager, but a close examination shows that the flowers contain in themselves no honey or anything else of that nature of value to the bats, but doubtless they harbour many small insects, and so the bats are attracted, for they find a generous meal in the depths of the flower with very little expenditure of energy.

A Wallaba tree (Eperua flacata) growing in the same gardens is also visited largely by what were first taken in the dusk to be big moths, but a more minute inspection showed that these "moths" were really little bats of a variety that has the same kind of brush-like tongue that a humming bird has, and whose name, Glossonyeteris geoffroyi gray, does not accord with their size. These little bats flit about and act precisely after the manner of moths. In both the Wallaba and the Bauhinia it is evident, from subsequent events, that the bats are the direct agents that bring about the cross-fertilisation of the flowers, and the transference of pollen is wholly effected during their visits.

Another plant that appears to be fertilised by bats is a Java creeper—by name Freycinia—which climbs to the very top of trees and produces pale rose-coloured flowers, some male and some female, among long, dark green leaves. Now a certain well-known bat, the Kalaya, or Flying Fox, particularly affects this creeper, for it tears out the three inner petal structures and devours the succulent tissue with avidity. But this wanton destruction by the bat is amply made up to the flower by the fact that, as it eats the petals of the male flower, its head becomes covered with pollen from the stamens; and while it munches those of the female its head perforce rubs some of its golden burden on to the stigma and so cross-fertilisation is ensured, and, though the flower loses its petals, it gains posterity.

We know, at present, no cases of pollination by bats in the flora of Europe.

Birds, too, must be classed among the rarer but undoubted agents of pollination. In Europe, perhaps, again, no authentic cases of regular pollination by birds are known, but in many other parts of the world—the Tropics, South Africa, Philippine Islands, New Zealand, Madagascar, &c., birds play a definite and prominent part in this work. Fritz Muller, whose researches into the pollination of plants are classical, says, "Humming birds, which constitute one of the most important groups of pollinators, are on the wing in Brazil throughout the year. Their activity in visiting flowers is far greater than would appear from accounts known to me. I could almost believe that the list of flowers not visited by them would be considerably smaller than a list of those that are visited" (*i.e.*, of Brazilian flowers). One reason why they have not received all the credit due to them as pollinators is because some of their species are so remarkably like a certain hawk moth—known as the Humming bird hawk moth—that frequently they have not been distinguished apart by naturalists. Bates, in "The Naturalist on the River Amazon," tells how he was completely deceived on various occasions, and once actually shot a Humming bird hawk moth for the bird itself.

The tropical Abutilons are flowers that are almost entirely fertilised through the agency of humming birds. Fritz Muller, writing from Brazil, says: "A large and beautiful humming bird, the black breast of which shines like a glowing coal whenever the bird is in any way excited, has, with his inconspicuous wife, made himself almost completely master of the Abutilons in my garden, and drives away all other species. All flowers that are not under cover are pollinated by him."

The climber Marcgravia (a Nicaraguan plant) carries on high pendulous flowers which hang in circles, a dozen or more together, from one stalk. Below the flowers sway numerous nectaries of pitcher form which hold large quantities of nectar. This attracts many insects, and they in their turn are sought by humming birds, who, in picking them out of the pitchers, rub their backs upon the drooping stamens and thus transfer the pollen from one flower to another.

In North America not only are many native flowers

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pollinated by humming birds, but also various species of European plants, which, in their own country, have their pollination performed by insects with long probosces; such plants, for instance, as the evening primrose, the red clover, and the figwort being visited and pollinated by these birds.

The banana is another plant that has this service frequently performed for it by birds. Indeed, its pollen is particularly adapted for this method of transmission, as the grains are bound together in numbers by threads, and in Natal birds of the Cinnyridæ species may often be seen in the banana groves carrying it about on their beaks. On the other hand, the bananas of Mauritius do not appear to be frequented by birds at all, and there the transference of the pollen is made by insects.

Though small birds, such as humming birds and honey-suckers, form the large majority of bird pollinators, yet in some cases much larger birds fulfil this office. For instance, the large flowers of Carolinea are far too big for little birds to negotiate, so they look to woodpeckers to be their pollen carriers, and these birds, no doubt, search both for honey and for insects in the recesses of the flowers.

In one curious case succulent petals are the bait held out to birds, just as they are to bats in the Bauhinia. The flower of a certain Brazilian tree known as Feijoa—a myrtle—is deep red and particularly striking. As it matures the red petals, which are then fleshy and sweet, roll up and disclose a shining white inner surface so that they form four little white rolls, which have been compared to omelettes. Anyway they are a *bonne bouche* to various birds who search them out and rapidly devour them, and during the meal successfully cover themselves with pollen. This pollen they carry away, and while feeding on the next similar flower rub some of it off on the waiting stigma, and meanwhile are again sprinkled with a fresh supply. But with birds, as with bats, there yet remains much to be added to our knowledge of them as pollinators.

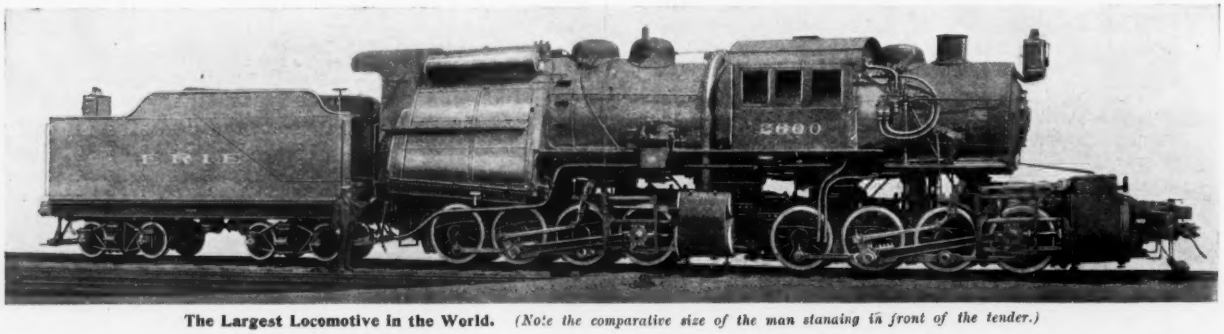
One of the most curious and certainly one of the rarest pollinators as a class are slugs and snails, yet they, too, must be classed among the direct agents of pollination. The plants that come under their influence—malacophilous plants—have usually small flowers set closely together, such as we find in the family of the Compositæ, or in the Aroids where male and female flowers are massed within a sheathing spathe, and snails as they wend their slimy way across them drag the pollen grains along and distribute them. A certain Italian, Delphino, was the first to call attention, a number of years ago, to this possibility, for he observed that in various plants under his observation, such as Rohdea japonica, Alocasia odora, Anthuriums, and others, only those which were touched by snails set seed, the others did not. Unlike birds and bats, snails and slugs act as pollinators in this country. For instance, the ox-eyed daisy is frequently visited by a small snail in wet weather when flying insects are not in evidence. The snail feeds upon the white ray petals, and as it crawls around it very effectually performs the insect's work of pollination. The same thing has been observed in the golden saxifrage, and also in the common duckweed. Hence, even if we consider that snails are "only the occasional and not the exclusive agents of pollination," these facts prove, as Ludwig observes, "that plants which lack the customary agents of pollination when continuous rains occur during the flowering season, and would otherwise produce no fruit, may find in slugs effective substitutes for insects which are only active in dry weather."

The Largest Locomotive in the World.

THIS colossal machine has just been built by the American Locomotive Company for the Erie Railroad. The special reason for using so extra powerful an engine is because of some long and steep grades which have to be negotiated by trains running from Susquehanna to Gulf Summit. Here is a stretch of eight miles long with a maximum grade of 1 in 77. Hitherto trains have had to be assisted over this portion by two or even three extra engines, which, of course, involved so many more drivers and firemen. The present engine is of the Mallet type, having one huge boiler to supply two separate engines, one high pressure and the other low pressure, each pair of cylinders being carried upon a separate truck and operating its own set of driving wheels.

This monster has a total weight of 410,000 pounds, or 205 tons, and the tractive effort is 98,000 lbs., but by a special arrangement this can be temporarily increased to 120,000 lbs. The high-pressure cylinders are 25 ins. and the low-pressure 39 ins. diameter, both having a stroke of 28 ins. The diameter of the driving wheels is 51 ins., and the total wheel base 39 ft. 2 ins.

What naturally strikes one about so huge an engine, with a length over all of 80 ft., is how it can negotiate the curves of the railway. The boiler, which is 35½ ft. long, is mounted rigidly on the after frame, but is supported on sliding bearings on the fore truck. The forward part is free to swing to right or left in rounding a curve.



The Largest Locomotive in the World. *(Note the comparative size of the man standing in front of the tender.)*

It is calculated that this engine could haul, on the flat, 250 loaded trucks, or a train nearly two miles long, at a speed of 8 to 10 miles an hour.

We are indebted to our contemporary the *Scientific American* for the details and illustration of this marvellous product of human ingenuity.

CORRESPONDENCE.

Distances of Stars.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The letter from Mr. Edward C. Durnford gives the scale for stellar distances which I used in some articles printed in "KNOWLEDGE & SCIENTIFIC NEWS," and in my "Road Book to the Stars." I further pointed out that if the distance of the earth from the sun be taken as one inch, then on the same scale the distance which light travels in one year will be represented by one mile. Stellar distances are quite often given by the number of years it takes the star's light to reach us, but, if only the parallax be known, the "light-years" are obtained by dividing 3.258 by the parallax.

I found the best way to get a clear mental image of stellar distances was to take a map, place the sun at Greenwich, and the stars as many miles away from it as they are "light-years" from the sun.

Yours, etc.,
T. E. HEATH, F.R.A.S.

Cardiff.

Mars and other Planets.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—It must not be forgotten that distance not only diminishes the apparent diameter of an object, but also, and in the same ratio, the apparent thickness of its integuments.

I have proved this by a converse experiment. A small insect so semi-transparent that its vital organs could be seen by the naked eye through its skin or flesh was magnified 1,000 diameters by a triplex microscope of double convex lenses. Nothing could be seen but the outer surface of its skin and a feathery down that grew upon it.

If a clear piece of thin glass is thus magnified, it becomes imperfectly transparent, because the otherwise invisible irregularities of its surface become visible.

I deduce from this that the distance of a planet from the earth diminishes in similar ratio the apparent depth of its oceans and the effects of depth.

A great deal of what we take to be land on a planet may be nothing but the bed of its ocean; invisible possibly to its own inhabitants, if such inhabitants exist.

Yours, etc.,
WALTER SEARGILL.

Colchester.

Springs on Hill Summits.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Your articles on Dew Ponds came so appositely to explain a question that arose when my brother and I were ascending, last month, some of the loftier summits of the Ligurian Alps that I am induced to write to you upon the subject.

It may interest those of your readers who have passed their summer in the British Isles to learn that this year has been one of exceptional drought in Southern Piedmonte. Springs that have scarcely ever been known to fail are dried up, and our noble Tanaro is a feeble, trickling stream. At the same time that no rain has fallen we have been afflicted by a warm, damp sea-wind, which the natives detest, and call by the opprobrious name of "Marinaccio." This wind, besides its legacy of headache, lassitude, rheumatism, and other ills, bequeathed us low, loose, misty clouds, enveloping the mountain tops, but very rarely yielding any rain. Now a special feature of these Ligurian Alps is the extraordinary fertility of the soil at altitudes which elsewhere in Italy would be nearly barren. On Mindino, over 6,000 feet above sea-level, the cattle pasture, and when we visited Galero, over 5,000 feet, the peasants were cutting hay on slopes so steep as to be hard to climb. Corn and potatoes flourish on these crests, and the magnificent forests of chestnuts that cloak the mountain sides remain green long into the autumn.

But what excited our curiosity and called for explanation was the fact that though all the springs were dry at the foot of the hills, at an astonishingly short distance from the summits there were abundant springs of delicious water, so fresh as to numb the hands. These showed no signs of diminution, unless I except one famous spring on the side of Galero, known as the Fontana delle Maraviglie. This Fountain of Miracles, it may interest to learn, obtained its name from the fact that until recent years its flow was regularly intermittent. After the great earthquake at San Remo, however, the Fountain entirely ceased to be miraculous. This summer it has regained the right to be so styled. When we visited it about mid-August, the water gushed in a small, but steady stream, making a loud gurgling; suddenly we were surprised by an unwonted silence; the spring had practically ceased to flow. This occurred several times during our rest, and we were able to certify that the pauses were regular, and at intervals of about fifteen minutes.

The question, however, that called for solution was, whence comes the inexhaustible supply which enables these springs—and they are many—so near the summits to hold out whilst all those in the valleys have completely failed?

Looking at the mass of the mountain which yields the water, that is to say, the volume of rock above the spring head, it seems impossible, even supposing the summit a hollow reservoir, that it can contain a supply equal to the output for a period of drought as great as that of the present year. I should mention that the snowfall here last winter, on which the peasants count for their supply of water in summer, was far below the average.

The conclusion we were forced to was that the thick covering of verdure on the hills gathers water from the moisture-laden "Marino" wind, and feeds the springs through crevices in the rocks.

It was interesting, on our return to the house, to find your Magazine with the account of Dr. Marloth's experiments on Table Mountain, which seemed to support our theory.

Yours, etc.,
WM. PARKINSON (M.A., Oxon.).

Garessio, Italy.

Solar Photography.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Readers of "KNOWLEDGE" engaged in solar observation may be glad to know of the following method of projecting the sun's image. A camera constructed of light wood is fitted with a screw cap in order to attach it to the eye-piece of the telescope. The surface on which the solar image is focussed is an ordinary photographic dry-plate (undeveloped), which is inserted in the place of the usual glass screen. The extreme smoothness of the film enables the smallest details of sun-spots to be sharply focussed, and faculæ are also well seen. The illumination of the image is perfect, as there is an entire absence of all glare. Another advantage is, that the telescopic image is seen exactly in the same way as a naked-eye view, as the screen is, of course, viewed from the back. The film permits of the finest ink lines being ruled upon it, and by allowing a sun-spot to transit a line and comparing the interval with the time taken by the whole disc, for a similar transit, a fairly accurate determination of the length of the spot may be made. For a telescope of 3 inches aperture, and powers 80 to 150, the best length for the camera is about 8 inches. I have employed this method for the past two years, as it enables drawings to be made without fatigue. The coming transit of Mercury will be best observed this way by the possessors of comparatively small telescopes.

Yours, etc.,
Purley. CHARLES W. RAFFETY.

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The Rotation of the Earth.

EXPERIMENTS have lately been made by M. Blum, with a simple apparatus, designed to demonstrate the effect of the rotation of the earth on the plane of oscillation and support of a simple pendulum.

The apparatus reproduces in all particulars the well-known observations of Foucault, an account of which was published in February, 1851.

The deductions then made by him were based on the results of suspending a heavy weight by a fine wire from the dome of the Pantheon, the upper extremity of the wire being attached to a steel point bearing in a steel cup. The pendulum being thus free to swing in any direction, a trace of its path was left in sand by a fine point attached to the bob.

The marks made by successive swings showed that

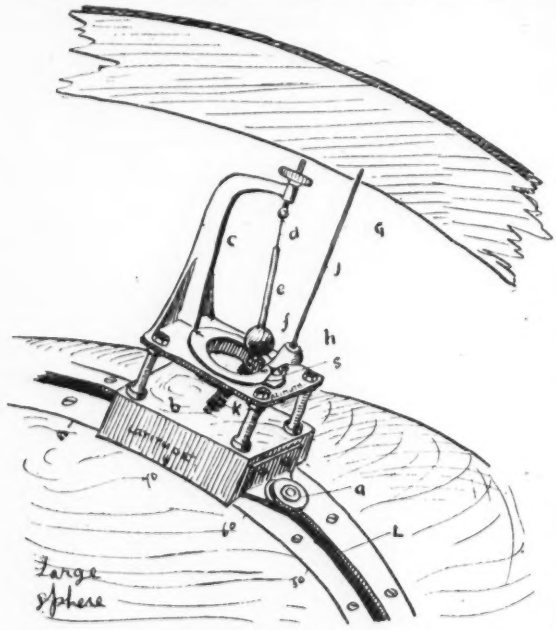


Diagram I.

Index of Parts:—

a Clamping Screw.	*e* Wood Strip.	*j* Starting Rod.
b Carriage.	*f* Wood Sphere,	*k* Spring.
c Gibbet.	*g* Fixed Great Circle.	*l* Demi-Meridian Slot.
d Thread.	*h* Ball Joint.	*s* Hook and Catch.

the plane of oscillation of the pendulum revolved with respect to the building.

Foucault concluded that the plane of oscillation must in any latitude appear to make a complete revolution in 24 hours × cosec. lat., so that at the equator the plane was stationary, and at the poles revolved once in 24 hours.

It is clear from the above that the latitude of any point on the earth's surface can be obtained by finding the angle whose cosec. is equal to (time in hours for a complete revolution of the plane of oscillation and support of a simple pendulum freely suspended at that point) ÷ (24 hours).

These results have lately been verified by M. Blum's simple apparatus, consisting essentially of a pendulum which can oscillate on a sphere at any latitude.

A small pendulum, composed of a slender strip of wood, 6 cm. long, weighted by a small wooden ball, 6 mm. in diameter, is employed.

This is carried by a gibbet attached to a rectangular platform, mounted on a carriage. The latter slides in a groove cut along a demi-meridian of a sphere 22 cm. in diameter, which can rotate in either direction about a vertical axis, so that the pendulum can be placed in any desired latitude by means of a clamping screw. The pendulum, whose axis passes through the centre of the sphere, is suspended from the gibbet by a thread, and is controlled by a spiral spring attached to the bob. When displaced from its normal position, it oscillates in a circular opening cut in the platform. A steel hook, which can be fixed at any point on the circumference of the hole in the platform, is used to hold the pendulum displaced from the normal position prior to releasing it, so that it may be started oscillating at any azimuth angle desired. This is supplemented by a self-starting gear releasing the pendulum after it has been set to the required azimuth by the hook.

When the globe is motionless the hook can be lifted with the hand, and, when rotating, it is lifted by a catch engaging with the inner edge of a fixed great circle surrounding the globe.

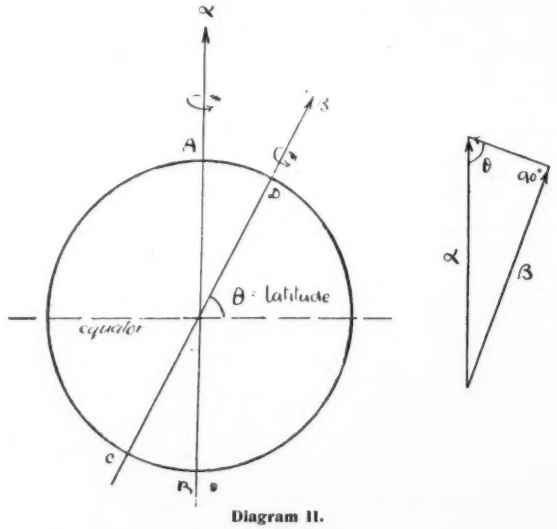


Diagram II.

The following results are recorded:—

(*a*) The plane of oscillation of the pendulum is invariable in direction, whatever may be the latitude of the pendulum and the azimuth in which it has been launched. This would, of course, be observed on a star without rotation.

(*b*) 1.—With the globe rotating, after a quarter of a turn, it is noticed that if the pendulum is at the north pole its plane of oscillation remains fixed in space—turning relative to the globe in the opposite sense, and at the same rate.

2.—With the pendulum at any other northern latitude, the plane of oscillation rotates relative to the globe with a speed proportional to the sine of the latitude.

3.—The speed of the plane of oscillation of the pendulum relative to the globe is zero at the equator for all speeds of the globe.

4.—In the corresponding southern latitudes the rates of rotation of the plane of oscillation are the same, but their sense is changed.

The proportionality of the speed of rotation of the plane of oscillation to the sine of the latitude is readily proved by the representation of angular velocities by vectors.

Let the vector α represent the angular velocity of the globe about the axis AB.

The vector representing the angular velocity of the globe about CD is the resolved part of α along CD, and is equal to $\alpha \sin \theta$ (*i.e.*, α sin lat.). This is β.

Clearly when $\theta = 0$ $\beta = 0$, agreeing with (3).

Also when in the southern hemisphere the apparent sense of β is changed, as observed in 4.

Another piece of apparatus, simpler than the preceding, but which does not yield such good results, may be used to demonstrate the change in sense of the deviation as one passes from one hemisphere to the other.

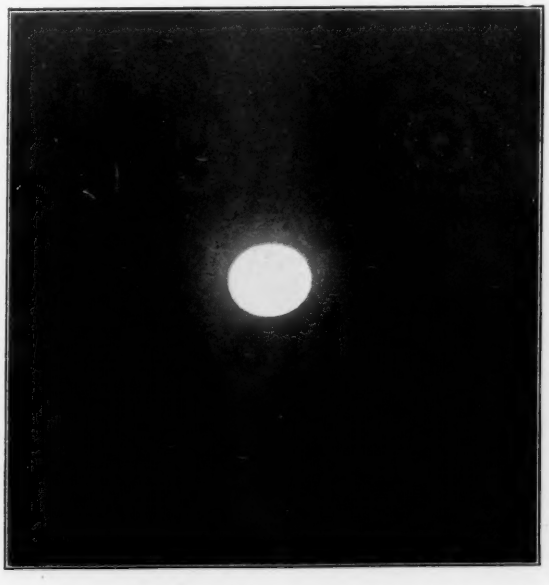
A gibbet carrying a pendulum similar to the one described above, but larger, is held in the hand, and its axis is caused to describe a cone with a vertical axis.

The conical motion of the axis of the pendulum causes the plane of oscillation to revolve with respect to the gibbet, the sense of rotation of the plane of oscillation being clockwise or anti-clockwise, according as the apex of the cone of revolution points upwards or downwards, or *vice versa*.

J. G. DAVIS.
H. F. PURDAY.

Photograph of the Setting Sun.

We reproduce herewith a photograph kindly sent by Mr. R. T. A. Innes, Director of the Government Observatory, Johannesburg, South Africa. It shows the setting sun, and it will be seen that the refractive effect of the atmosphere diminishes the vertical diameter by



more than one-eighth part. The photograph (taken by Mr. H. E. Wood) was obtained with a Dallmeyer-Zeiss telephotographic combination, the exposure being one second. It was taken on August 9 at 5h. 41m. 30sec., the sun's declination being 16° 3′ N. Johannesburg is in latitude 26° 11′ S

Photography: Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Exhibitions. The two principal photographic exhibitions of the year are now open and will close on the 26th of this month. The Royal Photographic Society occupies the "New Gallery," 121, Regent Street, and illustrates as far as possible photography in all its branches—scientific, technical, artistic, professional, and commercial, in the four or five rooms at its disposal. Doubtless the chief interest will centre in the balcony, where a large collection of colour photographs by Lumière's starch grain plates is on view, as this is the first plate commercially made that gives a result in "natural colours." These are transparencies on glass, and some of them are very fine, though no exhibitor ventures to submit a coloured original with the photograph of it, so that the two may be critically compared. But certainly one may say that the commercial preparation of such a plate brings to a successful issue a method that at first seemed almost hopelessly beset with difficulties. There is also a fine collection of natural history photographs, some astronomical plates of special interest from the Royal Observatory, Greenwich, an exhibit of the unique photographs of Mars by Professor Lowell, diffraction gratings of many kinds by Mr. F. E. Ives, and other items too numerous to mention. The exhibition of the "Photographic Salon" is at the Gallery of the Royal Society of Painters in Water Colours, 5A, Pall Mall East, and consists of a comparatively small collection which illustrates what photography is capable of in the strictly pictorial direction, though with little or no restriction as to hand work, providing that the result is harmonious. Both exhibitions are well worth a visit from all who are interested in photography.

Lippmann's Colour Photographs. There has always been a certain measure of mystery and hypothesis with regard to the nature of these directly one goes beyond the simple statement that the colours are due to interference. The simple fact that the silver is deposited in layers has been shown by several investigators who have photographed sections of the film, though it appears that some of these results represent diffraction effects rather than the real layers of silver. A recently published investigation by Professor S. R. Cajal, of Madrid, does a good deal towards demonstrating the actual state of affairs. He has photographed film sections showing various colours and white, in some cases rubbing away the surface so as to trace the effects due respectively to the surface layer and the underlying layers. As the resolution of these layers as produced by light of the shorter wave-lengths requires an objective of the greatest available numerical aperture or even beyond it, the method adopted was to swell the sections by soaking them in water. The results obtained seem to show conclusively that the structure of the films is more simple than had been supposed, white being due, not to a mixture of all colours or even complementary colours, but to simple reflection from a superficial deposit of silver, and light colours or tinted whites to the colours produced by interference from the underlying layers showing through the thin superficial layer which contributes the white that dilutes the colour. Pure colours, that is, unmixed with white, do not give this superficial reflecting layer, but show a thin layer of gelatine that is almost free from deposit

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in front of the first layer of silver. Although there may be half-a-dozen or more layers of silver in the film, it appears that the two uppermost are chiefly concerned in causing the colour, the third, perhaps, contributing a little. Those below are practically useless, as they are less well defined and, therefore, less effective, and only a small proportion of the incident light can reach them and be reflected by them. Extensive details of the experimental work are given in the original paper (*Zeit. Wissen. Phot.*, &c., p. 213, and an English translation in recent colour supplements of the *Brit. Jnl. Phot.*).

The Chemistry of Fixing.

The action of sodium thiosulphate on silver bromide (chloride and iodide) is of the first importance in practical photography, because it is a change that is included in the production of almost every negative and silver print. It is well, therefore, that Messrs. Lumière and Seyewetz, in investigating these changes, confirm, except perhaps in one or two trivial details, the ideas that have obtained currency. They confirm the necessity for using an excess of thiosulphate, the danger of using a fixing bath too near the point at which it ceases to fix, the existence of the two double thiosulphates of sodium and silver, the one (scarcely soluble) containing equal molecular proportions, and the other (freely soluble) with a double proportion of the sodium salt. It appears that when a solution of sodium thiosulphate acts upon silver bromide the first product is the soluble double salt, as one would expect, because the solubility of the sodium salt and practical insolubility of the silver bromide necessitate an excess of the sodium salt in a reacting condition. But these investigators have found that an excess of silver bromide does not act upon the soluble double salt replacing sodium by silver and so forming the insoluble salt. They find that this soluble double salt ($Ag_2S_2O_3$, $2Na_2S_2O_3$, $2H_2O$), in a solution of something under 1 per cent. strength, slowly decomposes and becomes brown because of the formation of silver sulphide, that stronger solutions decompose similarly if boiled, and that still stronger solutions (from 5 per cent. upwards) deposit the insoluble double salt ($Ag_2S_2O_3$, $Na_2S_2O_3$, H_2O) the more readily the stronger they are. The usual precautions mentioned above are necessary to prevent these decompositions. Silver chloride dissolves in a 15 per cent. solution of sodium thiosulphate in the proportion required to form the soluble double salt, but silver bromide is rather less soluble than the theory indicates. By using a stronger solution of the sodium salt a notably larger proportion of silver bromide dissolves, and as from these solutions the soluble double salt crystallizes either on evaporation or on adding alcohol, there appears little doubt that water in the presence of alkaline bromide tends to decompose the soluble double salt with formation of silver bromide and that this accounts for the solubility of silver bromide being a little below the calculated proportion. It is only fair to Messrs. Lumière and Seyewetz to say that the conclusions that I have drawn from their results differ a little from their own.

The Franco-British Exhibition.

THE Committee of the Science Section of this Exhibition (which is to be held at Shepherd's Bush next year) is composed of the following gentlemen :—

Sir Norman Lockyer, K.C.B., LL.D., F.R.S. (Chairman), Prof. John Perry, M.E., D.Sc., LL.D., F.R.S. (Vice-Chairman), Sir Wm. Abney, K.C.B., D.Sc., F.R.S., Major B. Baden-Powell, Prof. H. L. Callendar, M.A., F.R.S., LL.D., Major C. F. Close, R.E., C.M.G., Capt. Ettrick W. Creak, R.N., C.B., F.R.S., Horace Darwin, Esq., F.R.S., Prof. Farmer, F.R.S., D. S. H. Fowler, Esq., F.L.S., Rear-Admiral A. M. Field, F.R.S., Dr. L. Fletcher, M.A., F.R.S., Prof. Francis Gotch, D.Sc., F.R.S., M.R.C.S., Sir Archibald Geikie, F.R.S., F.G.S., Sir David Gill, K.C.B., F.R.S., Dr. R. T. Glazebrook, F.R.S., Col. R. C. Hellard, R.E., Col. Sir Thomas Holditch, K.C.M.G., K.C.I.E., C.B., Sir E. Ray Lancaster, K.C.B., F.R.S., Dr. W. J. Lockyer, Prof. R. Meldola, F.R.S., Prof. Henry A. Miers, D.Sc., M.A., F.R.S., Dr. H. R. Mill, D.Sc., LL.D., Prof. Poulton, F.R.S., D.Sc., Col. D. Prain, F.R.S., C.I.E., Sir Wm. H. Preece, K.C.B., F.R.S., Sir Wm. Ramsay, K.C.B., LL.D., M.D., F.R.S., Dr. Ridewood, Fredk. Wm. Rudler, Esq., I.S.O., F.G.S., Prof. E. Rutherford, F.R.S., Dr. W. N. Shaw, F.R.S., A. E. Shipley, Esq., F.R.S., L. S. Spencer, Esq., Dr. J. J. H. Teall, M.A., F.R.S., F.G.S., Prof. Sylvanus Thompson, D.Sc., F.R.S., Prof. T. E. Thorpe, C.B., LL.D., F.R.S., Prof. F. T. Trouton, F.R.S., Col. Sir Charles Watson, K.C.M.G., C.B., Sir H. Trueman Wood, M.A., and Sir Alexander Pedler, C.I.E., F.R.S. (Hon. Secretary).

Markings on Mercury and Venus.

IN 1896 Professor Lowell published in the *Monthly Notices* (vol. lvii., p. 148) a series of drawings of Mercury, showing extremely curious markings on the planet, which he speaks of as much more distinct than the Martian canals, and, in fact, quite easy to see. They appear to have been observed when the planet's surface was not more than half illuminated, and the drawings show them as linear in character, though otherwise they bear little resemblance to the canals of Mars. I give as an example Professor Lowell's drawing of September 23, 1896, in which the markings appear mostly as stripes projecting from the terminator or running parallel with it. There is also a slight shading off of the cusps.

Mercury.

Professor Lowell promised further communications on this planet, but I cannot find any later observations, his work having been recently mostly devoted to Mars.

He also published in the same number of the *Monthly Notices* some drawings of Venus, showing a number of singular markings like the spokes of a wheel, but in 1902 he wrote in the *Astronomische Nachrichten* (No. 3,823) that he had found reason to believe that these markings were due to an optical illusion. I do not know whether he still considers the markings on Mercury as objective, but those which he drew in 1896 do not seem to me at all like the canals of Mars, and, as far as I know, they have not been confirmed by other observers.

W. H. WESLEY.

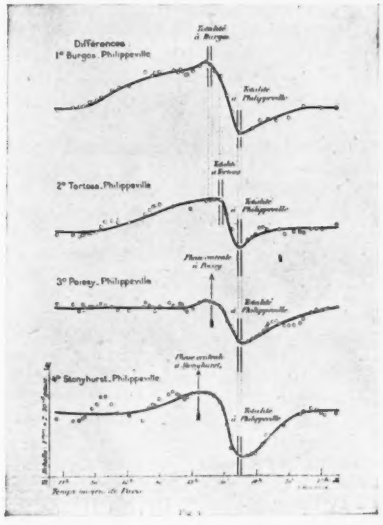
NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Variations of Terrestrial Magnetism during Total Solar Eclipse.

DURING the total solar eclipse of August 30, 1905, observations of the terrestrial magnetic elements were made by M. C. Nordmann, at Philippeville, Algeria, the declination and horizontal intensity being continually registered photographically. All the instruments were enclosed in a casement in which the temperature variation was less than 0°1 C. daily. By comparing the declination curves for the eclipse day with others obtained during the period August 14—September 20, it is found that: (1) The elongation of the needle to the west of the equilibrium position during the whole course of the eclipse was considerably less than the mean elongation; (2) none of the other curves recorded at Philippeville (on other days) during the above period show this peculiarity; (3) at the exact moment of totality, corresponding to the usual maximum elongation to the west,



there is shown a well accentuated minimum. Records of similar series of observations made at Burgos, Tortosa, Poisy, and Stonyhurst were next carefully examined, and it was found that, except for slight variations, all the prominent sinuosities were identical on each curve; moreover, they were all synchronous, *i.e.*, produced at the same physical instant. Taking then into consideration the whole of the curves, and eliminating the common features by subtracting the ordinates for each point, a series of values were obtained, representing differences of perturbation between each station and Philippeville. On plotting these residuals it was evident that they represented a real phenomenon, which depended entirely on the eclipse. For instance, taking the curve Burgos minus Philippeville, the curve rises to its maximum value at the precise time of totality at Burgos; then it descends very rapidly, and having passed through the initial values reaches a minimum coinciding with the amount of totality at Philippeville, rising again to its initial value. From this it will be seen that the effect of the eclipse is to cause a deflection of the needle to the east. The symmetry of the minimum and maximum of the curve proves that the magnetic effect accompanying the eclipse was of practically equal magnitude at the two stations at the moment of their respective totalities. The deflection at Philippeville amounted to about 3′ to the east, whereas normally the needle at eclipse time should be about 5′ to the west of its mean position. M. Nordmann proposes to explain this phenomenon by the direct action of the sun's heat on the earth's atmosphere. The upper air currents will be altered in electrical conductivity when they are immersed in the shadow, and this variation crossing the earth's magnetic field may induce sufficient electromotive force to influence the declination needle. In support of this view is cited the fact that the daily variation does follow the insolation almost exactly. On this idea the effect of the eclipse is not to produce an actual deflection to the east, but to diminish the action of whatever factor produces the westerly daily variation.

Spectrum of Comet Daniel (1907 d).

The French observers appear to have been very fortunate in their opportunities for work on this comet. At the Astrophysical Observatory of Meudon, MM. H. Deslandres and A. Bernard have successfully photographed the spectrum and discussed the probable interpretation of the lines found. Special apparatus was prepared, consisting of slitless spectrographs, and also others with the usual slits. The present note gives the results obtained with the slitless instrument, this being probably that of greatest efficiency. It gives the spectrum of the entire comet, and the confusion due to the size of the comet itself is minimised by reducing the focal length of the camera as far as possible. Two spectrographs of this type were employed (1) having a flint prism of 60° angle, with an objective of 21 cm. focal length and aperture 4.8 cm.; (2) with a prism and objective of quartz (ratio of aperture to focus = 1.15). They were carefully adjusted and rigidly mounted on an equatorial so that the edges of the prisms were parallel to the length of the tail of the comet. The mounting also carried a visual refractor of 6 inches aperture, and an ordinary photographic camera without prism. After the exposure on the comet spectrum, the spectrum of a bright star was photographed on either side of that of the comet, for determination of wave-lengths. In this way interesting negatives were obtained on August 9, 15, and 20, Lumière plates being employed.

The cometary spectrum is sharp and strong, consisting of the three bands, yellow, green, and blue (λ 473) usually ascribed to hydrocarbons, and also the ultra-violet cyanogen band (λ 388), which was first recognised in the comet of 1881 by Huggins. A peculiarity is that these bands, at least those of hydro-carbon, do not appear to show the usual maximum of intensity towards the more refragible edge, but this can only be definitely settled by discussion of the slit spectrograph plates, which will be given in a later note.

Besides these strong bands, the negative of August 20 shows several fainter ones, λ 458-452, λ 429-423, λ 404-400, which have the peculiarity that they are projected in the tail quite 45 minutes of arc from the nucleus, while the strong bands are confined to the neighbourhood of the head and nucleus. The nucleus also shows additional faint bands which are not represented in the tail, at λ 438-433, λ 423-420.5, λ 420-417.5, so that we are here furnished with a remarkable differentiation between the constitution of the head and tail of the comet. The chemical origin of these bands cannot be definitely stated at present. The central band, λ 429-423, is very near a strong band emitted by the blue cone of a bunsen flame, and the two feeble bands at λ 455 and λ 402 are near the two hydrogen lines of the secondary series, discovered by Pickering, in ζ Puppis.

Excellent photographs of the comet have been obtained at Greenwich Observatory with the 30-inch reflector. These show the tail to be composed of from 15 to 20 streamers,

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with indications of still more complicated structure. A beautiful transparency of one of these photographs may now be seen at the Photographic Exhibition at the New Gallery. Other photographs, taken with a Dallmeyer rectilinear lens, show the tail to extend some 7° from the head of the comet. The general direction of the tail was west, the streamers spreading out in fan-like form and curving round to the south.

Recent Investigations of Mars.

Professor Lowell states that the observations of Mars made during the summer of 1907 have been most satisfactory, and have furnished repeated confirmation of most of the appearances previously recorded. In a telegraphic communication (*Astronomische Nachrichten*, No. 4195, p. 323), he announced that the canal Gihon had been photographed clearly double, and in a special article (*Nature*, 76, p. 446, August 29, 1907) he gives a more complete account of the results obtained. From the fact that the observations were begun in March, three months and a half before opposition, it was possible to catch both polar caps, the southern one at its maximum, the northern one at its minimum extent. As the equator was then lying nearly in the plane of sight, these observations were made under more propitious circumstances than has ever been possible before. At this time the southern cap stretched over ninety-five degrees of latitude, the northern only over eight. From that date the decline of the southern cap and the building up of the northern was carefully followed, resulting in the confirmation of the curious manner of formation seen at the two previous oppositions.—(See "Astronomical Notes," September.)

The development of the canal system in the antarctic and south temperate zones is next described. After the melting of the south polar cap was all under way, canals began to make their appearance about it, leaving its edge and joining the rest of the system in lower latitudes. The Solis Lacus, in the region Thaumasia, was composed of two portions, a large oval portion to the east, and a smaller one to the west, from both of which canals ran into the dark areas. Those on the south, such as Ambrosia and Bethys, were darker and more pronounced than those running north, as Tithonius, which latter showed evidence of being in their dead, or skeleton, condition. Meanwhile, the equatorial canals were steadily fading, the whole process of evolution being similar to that observed for the northern canals in 1903.

On photographs obtained by Professors Lowell and Lampland the detail is extremely fine, and on some plates as many as fifty-six canals have been counted, and such delicate markings as the Fons Juventæ and the small canals leading into it appear unmistakably on the prints. Prints of these negatives, direct from Professor Lowell, are now being exhibited at the New Gallery Photographic Exhibition. So much is the promise that it may soon be possible to definitely assign positions to areas of Martian topography by measures of the photographs, and Professor Lowell repeats his firm belief that the appearances shown can only be explained by supposing the existence of intelligent constructive life on this very interesting planet.

BOTANY.

By G. MASSEE.

Branching in Palms.

THE usual conception of a palm is a plant having an unbranched stem, growth being effected by the continuous development of a single terminal bud. Dr. Morris considers that palms have normally an unbranched caudex. Dr. Ridley, on the other hand, considers that the greater number of palms are really branched at the base at least, and enumerates in the *Annals of Botany* a considerable number showing this peculiarity. The cocoa-nut palm is more frequently branched than any other member of the family. In many genera certain species never produce more than one stem from a single seed, whereas other species belonging to the same genus habitually produce lateral buds. *Caryota urens* has only one stem, *C. mitis* has several stems. Many other examples are given. The commonest form of growth in palms is seen in the rattans—*Calamus*, *Zalacca*, *Pinanga*, etc., which send out lateral buds one after another from the base. These buds become erect stems, so that the whole plant eventually forms a bush. In *Rhapis flabellifera*, and some others, lateral shoots grow for a considerable distance, usually underground, and produce erect stems at intervals.

Branching is sometimes due to the injury or destruction of the terminal bud in the date palms (*Phœnix*), but is not always or even commonly so in other palms. As a rule the apparent bifurcation is due to one of the branches being a lateral bud, often produced low down on a tall stem; this lateral bud often grows so rapidly that in time it equals the original stem in height and thickness.

Some palms produce bulbils in the axils of the sheathing bracts in place of a branch of the inflorescence. These bulbils take root and develop into fresh plants.

Fungi on Nests of Termites in Madagascar.

It is pointed out in *Comptes Rendus*, by H. Jumelle and H. Perrier, that there are strong reasons for believing that the termites of Madagascar cultivate certain kinds of fungi for food, as is known to be the case with ants and termites in other parts of the world. The fungus most constantly present is a species of *Xylaria*, allied to the English "candle-snuff fungus," so common on rotten wood. A species of *Xylaria* has recently been described as occurring in termite nests in Ceylon. A second fungus abundant on old, deserted nests belongs to the Gasteromycetes, or puff-ball family, and has been named *Podaxon termitophilum*. Species of *Podaxon* are stated to be very frequently met with on deserted ants' nests in South Africa, and in all probability are cultivated by the ants for food.

A Dwarf Coffee Plant.

A new species of *Coffea*, named *C. humilis*, from Sassandra, on the Ivory Coast, is described by A. Chevalier in *Comptes Rendus*. The plant rarely exceeds half-a-yard in height, and rarely bears more than three or four fruits. The plant differs from all other wild species in having two seeds present in the fruit. The plant is met with in the densest parts of the forest, and at present can only be considered as a botanical curiosity.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Old Roman Glass.

THE view formerly held that the old Romans did not know how to make colourless glass has been disproved by numerous discoveries of such glass, and additional evidence is furnished by the analyses of Herren Henrich and Roters. The fragments of brightly coloured glass examined by these chemists were unearthed in the course of excavations at Saalburg, near Homburg, and were undoubtedly of Roman origin. The colour ranged from dark to light green, while some fragments were nearly colourless. As was to be expected, the intensity of colour in the green glass was proportional to the amount of iron that was present. Thus the very dark green glass contained 1.74 per cent. of iron oxide, the medium green 0.82 per cent., and the light green 0.48 per cent. All the specimens were soda glass, and all contained traces of manganese. The colourless fragments contained 0.49 per cent. of iron oxide and 0.36 per cent. of manganese oxide, a result which indicates that even at that early date the use of manganese oxide in the production of colourless glass was known. This decolorising effect of manganese is to be attributed, not to any oxidation of the iron silicate to a lighter colour, but to the colour of the manganese silicate being complementary to that of the iron silicate, and thus yielding a colourless glass.

Most of the specimens of Roman glass to be seen in museums are of greenish colour, and it would seem that it was not until the first century A.D. that colourless glass became popular.

Decolorising Power of Animal Charcoal.

Animal charcoal has long been employed as an agent for removing the colour from coloured liquids, but no satisfactory explanation has hitherto been offered to account for the difference in this respect between animal and wood charcoal. In Mr. E. Knecht's opinion, the explanation is probably connected with the fact that animal charcoal contains from 5 to 7 per cent. of nitrogen, whilst there is only a trace of that element in wood charcoal. His attempts to eliminate the nitrogen by heating the animal product with caustic soda were only partially successful, the proportion of nitrogen in a typical case being reduced from 5.6 to 3.61 per cent.; but he found that the decolorising power, as tested upon solutions of dyes, was reduced as the percentage of nitrogen fell. From the results of his experiments he concludes that: (1) Fixed nitrogen is present in animal charcoal; and (2) The decolorising capacity is directly proportional to the amount of nitrogen.

The Production of Black Diamond.

A patent has recently been taken out in France by M. Bonnet, for a method of obtaining carbon in an amorphous fused condition. The apparatus claimed consists of a vessel of bronze or other metal containing two carbon electrodes, between which is a rod of pure carbon. Beneath this rod is a smaller vessel containing carbon bisulphide, which, when vaporised, will produce a high pressure in the vessel, but will not have any action upon the carbon. The carbon bisulphide is first converted into vapour by means of a slight electric current, and as soon as there is a high pressure from this cause, a high-tension current is passed through the vessel, with the result that in a few moments the carbon rod is fused and converted into the form of black diamond.

Tea and Tea Drinking.

Acting upon the suggestion of the Southwark Borough Council, Dr. Tebb, Public Analyst for the Borough, has made an investigation into the nature of the tea commonly drunk in London, and has published his results in an interesting pamphlet on "Tea and the Effects of Tea Drinking." He points out that when first tea was introduced into England it was looked upon as a medicine rather than as a beverage. In 1657 a merchant named T. Garwey published an advertisement sheet extolling the beneficial effects of tea, and inviting purchasers to taste it at his office in the City. The first official notice is found in an Act of Charles II., in which a duty of 8d. is imposed upon every gallon of tea sold. During the 18th century the drinking of tea gradually became fashionable, but it was not until well into the 19th century that its use became general. In the years between 1801 and 1810, the amount of tea annually consumed per head of population was only 1.41 pounds; but by 1901-3 it had risen to 6.10 pounds per head, a quantity much in excess of that consumed in most Continental countries. In some of the British Colonies, still greater quantities are drunk, the amounts in different parts of Australia, for instance, ranging from 6.41 to 10.07 pounds per head. This large consumption of tea must unquestionably have its effect upon the health of the nation; and there is medical evidence that many cases of lunacy are to be attributed to excessive tea-drinking. The chief active agent in tea is an alkaloid which is believed to be identical with the caffeine in coffee. It is to this alkaloid that tea owes its stimulating action upon the nerves. To the other important constituent, the tannin, are attributed most of the well-known injurious effects of excessive tea-drinking. In Dr. Tebb's experiments to determine the proportion of these two substances in the tea as drunk in London, infusions were prepared from 43 representative samples of different origin, eight grams of tea being treated for five minutes with 600 c.c. of boiling water in each case. The average amount of alkaloid found in the infusions from Indian tea was 2.84 per cent.; while Ceylon tea gave 2.64 per cent., and China tea 2.40 per cent. These corresponding amounts of tannin were 7.43, 7.85, and 6.08 per cent. respectively. In similar analyses of the teas sold by the four companies supplying most of the restaurants in London, Indian teas yielded infusions containing 2.04 to 3.02 per cent. of alkaloid and 6.03 to 9.74 per cent. of tannin; China teas, 2.15 to 2.51 per cent. of alkaloid, and 3.02 to 5.85 per cent. of tannin; and Russian tea, 2.30 per cent. of alkaloid and 5.36 per cent. of tannin. These results bear out the commonly accepted belief that China tea usually contains less tannin than Indian tea, and although this is not invariably the case, it is easily possible with the aid of analysis to obtain supplies of such tea containing a very low proportion of the injurious constituent.

GEOLOGY.

By Edward A. Martin, F.G.S.

History of the Geological Society.

Appropriate to the centenary celebration of the Geological Society comes the publication of Horace B. Woodward's "History of the Geological Society of London." By the time these notes are published, the centenary will have taken place, and the host of geological workers and professors from all parts of the world will be wending their way home, or will be scattered throughout the country studying the classical outcrops in our own land. Where present-day workers are counted by the hundreds, similar walks of geological science witnessed a hundred years ago but their single worker. The portraits of some of these are shown in the volume now issued. It is interesting to see the appearance of such men as Buckland, Greenough, Conybeare, Sedgwick, Murchison, Lyell, and William Smith, as in the flesh. Sir Archibald Geikie, our greatest living geologist, is seen in a fine photograph. William Smith, to whom geology owes so much, was the first recipient, in 1831, of the Wollaston Medal and Fund, although he was never a Fellow of the Society. A portrait of the "Father of English Geology," as Professor Sedgwick called him, appears in the book. The history is full of interesting information, and is a monument of the industry of the author and those who assisted him. The work first suggested itself to the author as long ago as 1863, when he was assisting in the library and museum of the Society. Much has happened since that date, and Mr. Woodward's experience gained since then has been invaluable in rendering the present volume the more successful.

Triassic Footprints in Cheshire.

The discoveries which have been made in Higher Bebington Quarry, at Storeton, Cheshire, of reptilian footprints, impressed on the soft marl by the *Cheirotherium*, *Rhynchosaurus*, and other reptilian creatures of Triassic times, come very opportunely just now, when we believe that an American monograph on Triassic footprints is in course of preparation. The two beds of marl in which they occur constitute but a small portion of the Keuper Sandstone, in which the quarry is worked, and to the accident of the formation of these beds of marl we are indebted for these and other similar reptilian evidences.

On the Origin of Ocean Basins.

In his recent paper, read before the Geological Society, on "The Constitution of the Interior of the Earth as Revealed by Earthquakes," Mr. R. D. Oldham, F.G.S., had endeavoured to throw some new light on the origin of oceans. He says that the attempts which have been made to account for the oceans and continents are all subject to an uncertainty, in that we have had no means of knowing whether it is a mere irregularity of form that has to be accounted for, or whether this irregularity is but the expression of a deep-seated difference in the constitution of the earth. From a consideration of deductions from various records

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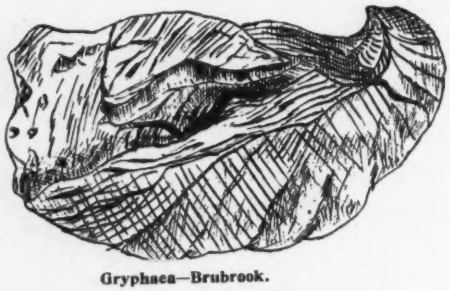
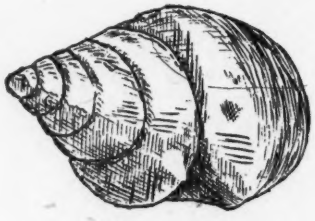
of the San Franciscan and Columbian earthquakes of April 18, and January 31, 1906, he concludes that oceans and continents are not mere surface irregularities of the earth's form, but are accompanied by, and probably related to, differences in the constitution of the earth beneath them, which extend to a depth of about one-quarter of the radius. It is not possible to state exactly in what this difference consists, beyond that it causes the rate of propagation of the second-phase waves to be less, in comparison with that of the first-phase waves, under the oceans than under the continents.

Comanchean Period Fossils.

By the kindness of an American geologist, I am enabled to figure some fossils from the Lower Cretaceous of the United States. It is believed these will be of interest to British geologists, as the specimens figured are not found in many of our museums. The period of the Lower Cretaceous beds is termed by Professors Chamberlin and Salisbury, the Comanchean Period. They say: "There was a somewhat widespread warping of the continental surface, resulting in sedimentation at many points within the continental borders. Submergence was extensive in Mexico and Texas. . . while on the Pacific Coast a narrow border of the present land was beneath the sea. . . . A prolonged period of sedimentation followed." From the physical standpoint, they add that the distinction between the Upper and Lower Cretaceous is greater than between the Cambrian and the Ordovician. The system may be known either as the Comanchean or the Shastan system. Correlated formations in Europe are the Aptian, Urgonian, and Neocomian (including Wealden).



Gryphaea—Brubrook.



Globiconica custa—Brubrook.

Lima roensis—Brubrook.

Exogyra arietina—Brubrook, Texas.

Toxaster elegans—Brubrook, Texas.

Ostrea larva—Marlboro, New Jersey.

Comanchean Fossils.—*From Drawings by E. A. MARTIN, F.G.S.*

The Cubic Contents of Ocean Areas.

The mean height of all the land now above the sea is referred to by Lyell as being 1,000 feet. The mean depth of the ocean is at least 12,000 feet, that is, it exceeds the height of the land twelve times. This is because the extreme heights of the land, although probably no less than the extreme depths of the sea, yet are exceptional heights, whilst the ocean maintains its depth over enormous areas. This fact may deserve attention in considering Mr. Oldham's conclusions above referred to. Owing, however, to the fact that the surface of the ocean to that of the land is as two and a half to one, the ocean would accommodate the whole of the land 30 times over, were it all pitched into the ocean areas.

Official Report of the Jamaica Earthquake.

An important publication of twenty-five pages has been issued by the Government Laboratory, Kingston, Jamaica, in which Mr. Maxwell Hall has concentrated all the available evidence collected from all parts of the Island on this subject. It will be remembered that the earthquake took place on January 14, 1907; the actual time was 3.29 p.m. (Kingston time), whilst a conference on agricultural affairs was sitting, delegates having attended from England, Canada, the United States, etc. There were thus a number of outside witnesses to the earthquake, which, it may be added, lasted for 20 seconds only.

The University of California Bulletins.

The geological bulletins of the University of California (Berkeley), issued with commendable rapidity, show the capacity of the University Professors to undertake the building up of the structure of facts, which must precede the unravelling of much of the complications of American geology. Volume 5, No. 7 Bulletin, deals with the "Fossil Fishes of California," by David Starr Jordan, and No. 9 Bulletin deals with "Benitoite, a new California Gem Mineral," by G. D. Londerback, with chemical analysis by W. C. Blaxdale. The suggested formula of the mineral mentioned is $BaTiSi_3O_9$.

METEOROLOGY.

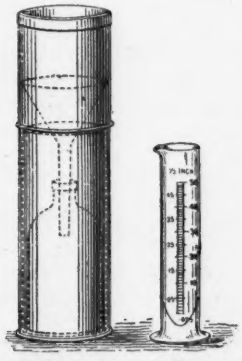
By W. MARRIOTT, F.R.MET.SOC.

Standard Rain Gauge.

WHEN the late Mr. G. J. Symons, F.R.S., founded the British Rainfall Organization, nearly fifty years ago, such observations as were being carried on were made with rain gauges of the most varied patterns, set up at any height from the ground that suggested itself to the observer, and read irregularly at almost any hour of the day or night. Since that time there has been a steady approximation to uniformity, and now the greater number of rain gauges in use are of a few definite patterns, set up for the most part at nearly the same height above the ground.

At a recent meeting of the Royal Meteorological Society, Dr. H. R. Mill read a paper on "The Standard Rain Gauge, with Notes on other Forms," in which he strongly recommended the Snowdon pattern of rain gauge, which is 5 inches in diameter, has a vertical rim to the funnel of 4 inches, and has an inner can and also a bottle. The larger Meteorological Office pattern of similar shape, but 8 inches in diameter, is equally accurate but unnecessarily large. Dr. Mill does not recommend rain gauges with

shallow funnels, nor the Glaisher pattern, the latter being particularly liable to give readings that are much too high when it begins to go out of repair.



Snowdon Rain Gauge and Measuring Glass.

The rain gauge should be so fixed in the earth that the top of the rim is one foot above the ground. It should be set in an open situation away from trees, walls, and buildings, and should be so firmly fixed that it cannot be blown over.

Whirlwind.

A Sussex correspondent of the *Evening Standard* (August 9) wrote: "A whirlwind has passed over Horsted Keynes, five sheep and a dog being caught up in the air and carried a considerable distance. They alighted in a field unhurt."

If the readers of "KNOWLEDGE" hear of, or are eye-witnesses of, any exceptional meteorological phenomenon, they are requested to kindly send an account of the same to the Secretary of the Royal Meteorological Society, 70, Victoria Street, Westminster, S.W.

Climate of Hebron.

Dr. A. Paterson, who is a Medical Missionary at Hebron, in Palestine, has an interesting paper on "Hebron and its Climate" in the Journal of the Scottish Meteorological Society. Referring to the climate, he says:—

"An observer may, through intimacy with the varying moods and phases of his local weather, be able to give a general impression of the climate in a manner which statistics hardly bring out.

In respect to the wind, the annual frequency of each direction in days is:—

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
48	18	29	27	9	8	82	144

We see at once that the north-west is the predominant wind; but with it may be grouped all with a westerly component, viz., south-west, west, and north-west, giving a total of 234 days. These are the winds which bring rain in winter, and they also blow steadily during the long, dry summer season.

NORTH WIND.—Biblical allusions to this wind are definite and interesting, representing it as three phases—wet, dry, and transitional. For example, Prov. xxv, 23 (R.V.), "The north wind bringeth forth rain; so doth a back-biting tongue an angry countenance"; and Job xxxvii., 21-22, which describes the clearing of a storm, with fine weather following: "And now men see not the bright light which is in the clouds; but the wind passeth and cleanseth them. Fair weather cometh out of the north."

By "transitional" is meant the phase in which the wind is veering from west to east. Thus in winter, by the time a westerly gale, after blowing for several days in succession, has worked round to the north on its way to the east, the storm of rain it brought has blown itself out, though there may be at this stage some final showers. And in summer, when for days together the day wind is west and the night wind east, the north is only a transient phase of the veering of the wind in the evening, as the south is in the morning.

SOUTH WIND.—In the transitional phase the south wind is very prevalent, much more so than appears from the records, because it is badly timed for actual observation, viz., early morning.

This daily rotation of the winds is probably referred to in Eccles i., 6: "The wind goeth toward the south, and turneth about unto the north; it whirleth about continually, and the wind returneth again according to his circuits." Summer and winter, however, the wind steadies for the most part somewhere in the west; the next stablest being the east, though far behind. With the Mediterranean on the west and the desert on the east of the two long flanks of Palestine, it is perhaps only natural that the winds from these "airts" should be the most prevalent and stable, and that the north and south winds should be more transient.

WEST WIND.—Summer or winter, then, the westerly winds (*i.e.*, south-west, west, north-west, tailing off into north) blow during more than two-thirds of the time, and always bring moisture. In winter this moisture yields five months of rain; in summer it is often not in evidence during cloudless days owing to the great heat, though on many summer days as well as nights great quantities of high and hard cumulus and cumulo-stratus fill the sky; but at night and in the early morning before sunrise, dense fog-banks or drifting scud, that blot out the landscape and drench everything, are common.

EAST WIND.—This is undoubtedly the next in frequency and importance to the west. It is with us the night wind of summer, and is not always a hot wind. About sunset, or later, a westerly breeze which has blown during the day veers by north-west and north to east, and during the early forenoon it continues its way round the compass to west again. This will go on sometimes for several days in succession. But the true east wind, or sirocco (Italian for Arabic sharkiejyeh, or easterly), which blows sometimes for two or three days on end, is a different matter.

The references to it in Scripture are numerous. Job i. 19: "And, behold, there came a great wind from the wilderness, and smote the four corners of the house, and it fell upon the young men, and they are dead" (probably the collapse of a tent and subsequent death by suffocation). Jer. iv., 11-12: "A hot wind from the bare heights in the wilderness . . . not to fan nor to cleanse." (The reference is to Jerusalem). Ps. xlviii., 7: "With the east wind Thou breakest the ships of Tarshish." Hos. xiii., 15: "An east wind shall come, the breath of the Lord coming up from the wilderness, and his spring shall become dry, and his fountain shall be dried up." Jonah iv., 8: "And it came to pass, when the sun arose, that God prepared a sultry east wind; and the sun beat upon the head of Jonah, that he fainted."

Far short of such extreme exhibitions of itself, the east wind can inflict intense discomfort and work much damage. Only once have I witnessed an exhibition at all approaching a typical sirocco, and then the atmosphere was like a London fog.

Rarely is the east wind a carrier of rain, but twice in thirteen years I remember wet weather which beat up from this side, so that we had to close our easterly windows, which may with impunity remain open during the heaviest westerly rains.

RAINY SEASON.—The usual progress of the rainy season is in a more or less regular series of alternations of wet and dry; paroxysms, so to speak, of storms intermitting with spells of the finest weather of the whole year, the wet bursts being usually shorter than the dry intervals.

Take the following as an average example of our winter weather. After ten days or a fortnight of sunny weather, sometimes indeed cloudless, if the east wind has prevailed, suspicious-looking clouds appear on the western horizon, banking up from small beginnings: "Behold, there ariseth a little cloud out of the sea, like a man's hand" (1 Kings xviii., 44). Gradually the wind rises, and the sun becomes

completely overcast. This may take a day or two, or only a few hours. Usually as long as this rising wind continues strong, the clouds hold up, but a lull in its violence, for which we know to look, is quickly followed by torrents of rain.

Then for three days and nights, often more, up to ten days on rare occasions, the heavens are obscured, and a gale, unremitting and violent, drives all life underground and indoors. At last the wind moderates, the cloud-pall, having meanwhile begun to harden, lifts and breaks up, and at ever-shortening intervals sun or stars begin to show as the clouds disperse. Next day breaks fine, or if the wind has veered to the east, cloudless. Then follows an interval, usually of a week or fortnight, of the most wonderful weather, with brilliant and warm sunshine, balmy and invigorating air, and high and hard cloud-masses, brilliant and snow-white, or lovely mackerel in the bluest of skies, which, ultramarine at night, make the moonlight a never-to-be-forgotten spectacle of loveliness.

Now all life revives, and as the weeks pass the grass seems to grow visibly and the lean cattle to fatten before one's eyes, while all manner of activities which were in abeyance during the storm—ploughing, sowing, building, every sort of out-door labour—are again, and at once, in full swing, and traffic, which has ceased because of risk to life and limb of man and beast, is again on the move. Wherever the water can run off, the roads and tracks dry in an incredibly short time.

Symons's Meteorological Magazine.

The five-hundredth number of this Magazine was reached last month. This is a fact of no little interest, when the smallness of the public to which such a journal appeals is taken into account. When Mr. Symons produced No. 1. in February, 1866, he had already issued a "Monthly Rain Circular," as a supplement to "British Rainfall," for several years, so that a greater antiquity might be plausibly claimed for the Magazine than the numeral implies.

The editor is Dr. H. R. Mill, and he says: "The Magazine, though small, has grown, and is not, we trust, incapable of further growth without departing from the original lines on which it was planned. As an independent organ of opinion in meteorological matters, it has, we believe, been of use in the past, and we hope that this usefulness will continue. We heartily thank the many friends who have helped us hitherto, and we look forward with confidence to a wider circle of readers."

We trust that all interested in meteorological matters will become regular subscribers for this useful and interesting monthly Magazine.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Bearded Titmouse.

BUT for the most zealous protection, the Bearded Tit (*Panurus biarmicus*) would probably have long since been exterminated as a British bird. Happily, it still thrives, and is perhaps even increasing in one of its last strongholds—the Norfolk Broads.

Only a few of the Broads, however, are now tenanted by these charming little birds. During the early days of September, we had the good fortune to see several pairs of these birds on two different Broads some miles apart. And on one of these, to our great delight and surprise, we were shown a nest containing fully fledged young. The birds began to breed this year so early as March, and one pair, we were assured, had reared no less than five broods! If no mistake has been made this pair must have passed a very arduous summer. Another pair is said to have reared three broods. This beautiful little Titmouse is all the more worth preserving because so little is known as to its affinities. Though generally described as a Titmouse, it is doubtful whether it is really related to the Paridæ, but exactly what its true position in the system is remains to be discovered.

Spotted Redshank in Norfolk.

An adult specimen of the Spotted or Dusky Redshank (*Totanus fuscus*) was shot on Hickling Broad on August 30. On the following day a second example was killed, and on the 31st, a third. Probably more examples of this bird have been killed in Norfolk than in any other county.

Early Appearance of the Fieldfare.

Mr. F. W. Frohawk, in the September issue of *British Birds*, records the fact that on August 14, last, he was handed a specimen of the Fieldfare, which had been killed the previous day at Hockley, Essex. It would be interesting to know whether any of our readers have come across examples of this bird during August.

Position of the Ear in the Woodcock.

In a recent issue of "KNOWLEDGE," we referred to a curious point with regard to the position of the ear in the Woodcock, pointing out that this aperture was placed below the level, and in front, of the eye. In the *Field* (September 7), a short article, accompanied by a photograph, appears. The writer admits, somewhat grudgingly, that "if a perpendicular be let fall from the pupil of the eye it will fall just behind the aperture of the ear, and from this point of view the ear might be described as being in front of the eye." But there can be no doubt that the aperture of the ear is actually in front of the eye, as may be shown if a line be drawn vertically, in front of the eye, so as to intersect a line at right angles to this drawn along the cleft of the beak. Further, in the Snipe this aperture will be found, as has already been described, further back than in the Woodcock—beneath the eye in short, and not in front of it.

Montagu's Harrier in Ireland.

The *Zoologist* for September records the fact that an immature male Montagu's Harrier (*Circus cineraceus*), was taken in a trap on a grouse-moor in June, near Sallygap, Co. Wicklow. It was discovered nailed up with other "vermin" near a keeper's cottage.

Osprey in Ireland.

Mr. W. J. Williams writes to the *Zoologist* for September to say that an adult male Osprey was shot near Drogheda, on May 1, by a gamekeeper, and remarks that "It is a pity this harmless species is molested." We quite agree with him.

Scops Eared Owl in Ireland.

On May 6, a male Scops Owl was caught, according to the *Zoologist* for September, at the lantern of the Fastnet Lighthouse, this making the seventh record of the kind for Ireland.

PHYSICS.

By PROF. ALFRED W. PORTER.

A New Radio-Pyrometer.

SINCE our knowledge of the laws of radiation has been made precise (thanks to the work of Wien, Lummer, Stefan, Boltzmann, Pringsheim, Rubens, and others), it has become evident that the best manner of measuring high temperatures consists in evaluating them by means of the radiating power of the bodies whose temperature is required. Even before this precision in the theory had been obtained, M. Le Chatelier had recognised the advantages which radio-pyrometry would possess, and had devised an instrument for the purpose. In 1904, M. C. Féry devised such an instrument, based on the employment of the total radiation focussed on a minute thermo-electric couple. The current produced is measured by a galvanometer, and is proportional to the total radiation, and, therefore, also to the fourth power of the absolute temperature, provided that the object

examined is a perfect radiator (*i.e.*, a perfectly black body, so-called). An instrument of this kind may be as much as fifty metres from the furnace, and may be made to automatically register the changes in temperature by attaching a tracing point to the needle, and causing it to move over a rotating drum.

M. Féry has recently modified this instrument by substituting for the thermo-couple a bi-metallic thermometer, that is, a spiral strip consisting of two metals soldered or welded together throughout their whole length—a Bréguet thermometer, in fact. Owing to the different expansive powers of the two metals the spiral curls up or unwinds with changes in temperature. The one employed here has an external diameter of only two millimetres. The outermost end is fixed; the central end of the spiral is attached to a small plate, which carries the registering needle. All is blackened. The radiation from the furnace is focussed upon the spiral and what escapes it is caught by the disc, so that all is utilised. The instrument is arranged to work between 600° and 1300° C. By means of a diaphragm the sensitiveness can be adjusted so as to alter the range from 1200° to 2900° C., and thus to include practically the highest temperatures employed in practice.

Influence of Temperature upon Photo-Electric Effects.

When ultra-violet light is incident upon negatively charged metals they gradually discharge. Two views have been held regarding the mechanism of this discharge. According to the first view it is the quasi-free electrons—which take part in electric conduction—which acquire sufficient additional kinetic energy from the light to enable them to overcome the attraction of the metal. According to the second view the electrons concerned are constituents of complex atomic systems, which become unstable under the influence of the light, and they become projected from these systems with velocities not greatly different from those which they possessed inside the atom. If the first view were correct, temperature might be expected to have considerable influence upon the rate of discharge; for the quasi-free electrons possess a velocity, given by the ordinary gas theory, which is proportional to the square root of the absolute temperature; therefore, at high temperatures less increment of energy would be required in order that the attraction of the metal might be overcome, especially as the attraction, if also a function of the temperature, probably decreases as the temperature rises. According to the second hypothesis, the velocity possessed depends upon the internal constitution of the atomic system, and may be expected to be independent of temperature. It becomes important, therefore, to prove whether or not temperature has any influence. Evidence so far has been very conflicting; but it has to be borne in mind that experimentalists have nearly always made their observations in air or other gas. All such experiments may at once be ruled out, for the presence of a gas introduces so much complication that the true photo-electric effect is masked. Elster and Geitel alone, till recently, record measurements made in a good vacuum, the metal upon which they worked being potassium, and obtain an increase with increase in temperature. The question has now been fully investigated by Professor Millikan and Mr. Winchester, and their latest account is given in the *Philosophical Magazine* for July, 1907. Experimenting in the best possible vacuum on the metals copper, gold, nickel, brass, silver, iron, aluminium, magnesium, antimony, zinc, and lead, they find no effect whatever from a rise of temperature from 25° C. to 125° C., upon the rate of discharge of negative electricity under the influence of light. In the same paper they show that the positive potentials acquired by the same metals when under the prolonged influence of the light are also independent of temperature, a result which led to Lenard's conclusion that the only forces resisting the expulsion of the negative particles are electrical in their nature. They further confirm Lenard's conclusion that the positive potential acquired is independent of the intensity of the incident light. They have come to the following conclusions, which differ from those which have frequently been arrived at when the experiments were conducted in air :—

The order in which metals in a vacuum exhibit photo-electric sensitiveness bears no relation whatever to the volta contact series. The order obtained is that given in the above list, with copper at the top, and lead at the bottom.

The order in which the metals arrange themselves with respect to the positive potentials assumed in a vacuum under the influence of ultra-violet light bears no relation to the volta contact series.

Clean, unpolished metals exhibit in a vacuum under the influence of a given source perfectly definite and constant discharge rates. If fatigue effects occur at all, the recovery from them is complete in the course of a few minutes.

Of course, these statements are not a denial of the reality of the similarity with the volta series, when the experiments are conducted on a gas. In such cases the complication due to the gas is of the same kind as that which gave rise to the great controversy on the seat of the electro-motive force of a voltaic cell.

Influence of Gravity upon Induced Radio-Activity.

Madame Curie finds that the active deposit resulting from the decomposition of a constant amount of radium emanation is precipitated upon plates in amounts depending upon their position. The activity of plates facing upwards is always greater than for other positions. The effect is the same as though the deposit consisted of heavy particles falling through the gas. When no gas is present, however, the amount does not depend upon the aspect of the plate; and to the present writer this fact is in opposition to the view that the action is a direct gravitating one, for falling would then be still more complete in the absence of the gas. The action is apparently a secondary one, in which gravitation is involved. This conclusion seems to be borne out by the further fact that the presence of moisture is also necessary.

ZOOLOGY.

By R. LYDEKKER.

The Arab Horse.

IN my notes in the September number, there occurs a misstatement with regard to the Arab Horse. The skeleton of Napoleon's Arab, "Marengo," is preserved in the Museum of the United Service Institute, Whitehall.

The Arrow-Worm.

A certain number of animals are a constant source of trouble to naturalists on account of the difficulty of assigning them their proper systematic positions. Among these is the marine creature commonly known (from its shape) as the arrow-worm, and scientifically as *Sagitta*. In modern text-books these curious organisms (for there is more than one species) are classed with the worms; but there was an old idea that their real position is among the molluscs. This view has been revived and strengthened by Dr. R. T. Günther, who, in a paper contributed to a recent issue of the *Quarterly Journal of Microscopical Science*, definitely places the arrow-worms in the Mollusca; their nearest relatives, in his opinion, being the nautilus and cuttle-fishes.

The Name "Ambergris."

I have often wondered why the name "ambergris" (*i.e.*, grey amber) was applied to the well-known aromatic substance so largely used by perfumers. Ambergris is a biliary secretion of the sperm-whale, and is generally found floating in the shape of irregular masses of variable size on the surface of the ocean. Now it appears, from a paper by Mr. P. Haupt, recently published in the *Proceedings* of the American Philosophical Society, that *ambar* (*i.e.*, the creature moving in the waters) is the Arabic name of the sperm-whale; and hence we have "grey ambar," or

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"ambergris," as the designation of the grey aromatic substance yielded by that creature, while another product, the glistening white spermaceti, is known as "white ambar," or "amberblanc." In the Ethiopic Bible, *anbar*, another form of *ambar*, is used for Jonah's whale; and this suggests that sperm-whales were formerly common in the Mediterranean, where they are now very rare, if not altogether unknown. This is confirmed by the fact that sperm-whales are mentioned, under the name of *nâkhiru* (*i.e.*, "blower," equivalent to the Greek *physeter*, which has the same meaning), in Assyrian cuneiform inscriptions, dating from between 885 and 860 B.C. Mr. Haupt is thus led to conclude that Jonah's whale was certainly a sperm-whale. He also points out that there appears to be some connection between the scriptural narrative of Jonah and the classic legend of Andromeda and the sea-monster; and that in ancient times the skeleton of a sperm-whale (the sea monster in question) was fastened by chains to the rocks at the entrance of one of the harbours at the eastern end of the Mediterranean.

The Baby Giraffe.

The event of the month is the birth, in the Regent's Park, of a young giraffe. On its arrival in the world, the interesting infant was something over five feet in height. Although both parents belong to the north-eastern type, the young approximates in colouring to the Nigerian representative of the species. Another noteworthy feature is that the "baby" was born with a well-developed pair of horns, which were loosely attached, and lay flat on the forehead. In a somewhat older calf of the Kilimanjaro giraffe in the Natural History Museum the horns are represented chiefly by tufts of long, black hair. Is this another racial distinction? That it cannot be explained by sex is evident from the fact that the "Zoo" specimen is a female.

REVIEWS OF BOOKS.

ASTRONOMY.

Astronomy for "the Man in the Street," by The Rev. E. A. Selley. (Dublin: Sealy, Bryers, and Walker, 1907; London: King, Sell, and Olding, Ltd., and Simpkin, Marshall and Co.; pp. v. and 382; 5s. net).—We give above the title from the front cover and title page. On the back it is called, "Astronomy Up-to-date," and on the back cover, "Tit-Bits of Astronomical Science." The author describes himself as a lecturer in astronomy, and this book purports to be the substance of a set of lectures on solar and planetary astronomy. If the present volume meets with favour another may follow, dealing with stellar astronomy. But it is one thing to deliver a lecture to a good-humoured Irish audience; and quite another to prepare the same lecture for publication. The jokes and funniments, the repetitions, the unfinished sentences, the frequent *lapsus linguæ*, the many mannerisms of a lecturer can be carried off easily enough at the time in the unlikely event of any special notice being taken of them, but in cold print (and in places the book reads like a verbatim report), they are often atrocious. The author reminds us with irritating frequency that he is talking to "the man in the street," very rarely even omitting the inverted commas, so that anything profoundly scientific is not to be expected; but surely the man in the street does not wish his facts to be *altered* in order to bring them down to his level. It sounds pretty to say that in 12,000 years' time Christmas Day will come in the middle of the summer, but it is sheer nonsense nevertheless. Perhaps the author is referring to the Precession of the Equinoxes (or Nutation, which he apparently takes to be another name for the same thing). Father Selley's choice of words is singularly unfortunate at times; for instance, he calls the periodicity of sun-spots a *paradox*, and an eclipse, a weird *freak* of Nature. Surely "a little learning is a dangerous thing." We can select samples of the author's scientific accuracy in many directions, *e.g.*, arithmetic: "Old Maids on Venus." Venus has a year of 7½ of our months, therefore one of our old maids of 40 would be *only 25* on Venus, or, *putting it another way*, the same old maid *will be 55* on Venus. Obviously, the correct number is 64. Again, try physics. Lunar gravity, on account of the small mass of the moon is much less than that on the earth, therefore, says our author, if you take a pound weight from earth to a "lunar baker" and get an equivalent weight of bread, you will find on reaching the earth again that you have only about three ounces of bread. This is absolute nonsense, but is on a par with another statement, that gravity being greater at the poles, a pendulum will swing quicker *at the equator*. This latter statement *may* be a *lapsus linguæ*, but the lunar baker is given in all seriousness. It would be charitable to explain Gill's parallax observations "*at* Victoria," and "meridians of latitude," as due to careless proof reading, especially as it seems likely the author did not read the proofs himself. We will quote one or two "Tit-bits" as additional evidence of "carelessness." "The sun not occupying the centre, but being more to the right or left of the centre of the flattened circle called the 'foci' of an eclipse." "The north pole is not vertically pointed due north above us, but is inclined at an angle of 23½°." Perhaps a wealth of Celtic gesticulation might render these sufficiently lucid to an audience, but in print they are very unsatisfying. The author's personal opinion is given prominence on certain questions, but in some cases this only amounts to the accepted view, as if one should say, "My personal opinion is that blood circulates through the system. You will find support for this view in the works of Harvey and others." But this is not so in every case, though he makes too much fuss about such discredited theories as Dr. Wallace's "Man's Place in the Universe." In fact, he does Dr. Wallace less than justice, for he brings a specific charge of cowardice against him, the foundation for which is a complete misunderstanding of a plain English sentence. Dr. Wallace wrote: "The probabilities are *almost as great* against any other sun possessing inhabited planets"; meaning, of course, almost as great as he considers them to be against any other planet in the solar system being the abode of human life. Father Selley goes out of his way to assume that Dr. Wallace means "almost as great *against*" as *for*, and hence claims that Dr. Wallace admits that the probability is against his own conclusion, and yet is not man enough to say so. The question of the habitability of Venus, for which Father Selley has a strong bias, depends, as he says, very much on the rotation. Schiaparelli and Lowell, he admits, are against a quick rotation period, but he quotes Cassini of all people against Schiaparelli (one might as well quote Galileo on sun-spots against Professor Hale), and gives a warm welcome to the spectroscopic determination of Belopsky (*sic*) ignoring that of Slipher. Without presuming to give an authoritative decision on what is still a debatable question, one would be tempted to inquire "If the rotation has been so well determined at a period not largely differing from 24 hours, how comes it that the rotation *axis* is, by the author's own showing, practically unknown? He also favours a quick rotation period for Mercury, which he says has been *decisively proved* by Mr. John McHarg, of Lisburn. We live and learn, but if this is really the case it is a pity Mr. McHarg should hide his light under a bushel. Of pure hibernicisms, we have not noted many in the book (perhaps this is due to the proof reader), but the following though poor specimens, we did come across: A man often sees stars, occasionally meteors, and "still *less* occasionally comets." The *four* more remarkable planetoids are Ceres, Pallas, Juno, Vesta, *and Eros*.

METEOROLOGY.

Meteorological Observations made at the Perth Observatory, and other places in Western Australia, during the year 1905, under the direction of W. Ernest Cooke, M.A., F.R.A.S., Government Astronomer (Perth: 1906, foolscap; 143 pp.).—The Perth Observatory is situated in south latitude 30° 57′ 10.27″, and east longitude 7h. 43m. 21.74s. It stands in the middle of a reserve of about 11 acres, on the top of Mount Eliza—a hill rising from the western boundary of the city to a height of about 200 feet above sea-level. A set of meteorological instruments was first mounted in a Stevenson screen, on January 1, 1897, and observations have

been taken regularly at 9 a.m. and 3 p.m. since that time. The present report contains the observations in detail for the year 1905. The highest temperature was 99.0°, on February 16, and the lowest 38.9°, on August 13. The mean temperature for the year was 63.6°. The total rainfall was 34.61 ins., which fell mostly between April and October, and the number of wet days was 116. The total amount of evaporation for the year was 65.32 ins. The gauge used is a slate tank, 3 feet by 3 feet, and 3 feet deep, and it is placed inside a cement one, leaving 5 inches clear all round. Both tanks are sunk in the earth, so that their tops project 6 inches above the ground level. They are filled with water, and a protected float in the inner tank registers the amount of evaporation daily. The amount of bright sunshine registered during the year was 2,703 hours—which is about 1,000 hours more than is usually recorded along the south coast of England The report also contains the monthly results of observations at 50 out-stations, and the monthly rainfall at 394 rain-gauge stations. Morning and afternoon forecasts form part of the routine work of the Perth Observatory.

NATURAL HISTORY.

The Cambridge Natural History, Vol. I., Protozoa, Porifera, Coëlenterata and Ctenophora, and Echinodermata (London: Macmillan and Co., Ltd., 1906; 17s. net).—Slowly but surely the "Cambridge Natural History," of which the first volume made its appearance so long ago as 1895, is nearing completion, only one volume remaining to complete the tale of ten. With the exception that Miss Sollas takes the place of her father as author of the section on the Porifera (sponges), the contributors whose names appeared in the original advertisement have been enabled to complete their allotted tasks. Professor Hartog is responsible for the Protozoa; Miss Sollas has had the advantage of her father's assistance in her account of the Porifera; Professor Hickson has undertaken the Coelenterata and Ctenophora; while Professor MacBride, of Montreal, is the author of the section on the Echinodermata. A better qualified quartette it would be hard to find. The present volume, despite its late appearance, being the first of the series, it falls to the lot of Professor Hartog to discuss that much misunderstood unit the organised "cell," and this he does in an especially lucid and interesting manner, making it perfectly clear that "sarcode" and "protoplasm" are the precise equivalents of the term "cell" in its modern signification. Mr. Hartog has also been fortunate in having to describe what is practically a new chapter in natural history, namely, the blood-parasites, such as those of malaria, now included, together with the long-known Gregarinida, under the title of Sporozoa; and this part of his task he has discharged in the same praiseworthy manner. To refer in detail to the other sections of the work—much less to criticise them—is an absolute impossibility within our limitations of space, and all we can do is to express our high opinion of the value of the volume, which appears to be one of the best in an excellent series. A praiseworthy feature of this volume, as of the series as a whole, is the comparative simplicity of the language employed, thus rendering the text capable of being understood by all who have mastered the rudiments of zoology. We may also congratulate the writers on their Cambridge toryism in preferring the old-fashioned Echinodermata and Coelenterata to the radical (if not socialistic) Echinoderma and Coelentera.

PHOTOGRAPHY.

Investigations on the Theory of the Photographic Process, by S. E. Sheppard, D.Sc. (Lond.), and C. E. Kenneth Mees, D.Sc. (Lond.) (London: Longmans, Green, and Co., 1907; price 6s. 6d. net).—The authors state that their volume is in no sense to be accepted as a text-book or an authoritative pronouncement on the theory of negative making, but that it is simply a collection of the accounts of certain investigations that they have carried out during the past four years. Everyone who takes a scientific interest in photography will feel grateful to the authors for putting together in convenient form the papers that they have read at various societies, and also for giving such numerous references to publications of matters that are more or less allied to the subject. Although the expression in the title "The Photographic Process" refers only to the physical chemistry of the exposure, development, fixation, and sensitometry of photographic plates, the authors have worked at a great variety of problems in connection with these subjects, and sometimes in reading the volume one wishes that they had spent all their time upon one or two only, so that they might have more conclusively dealt with them. But as much of the work was done in the preparation of theses for their degrees, it may have been necessary to cover a great deal of ground.

The authors regard the subject exclusively from the standpoint of modern physical chemistry, and express themselves in the language associated therewith. This will prove a grave stumbling block to many practical photographers who would like to become acquainted with the results of their investigations, but are not familiar with the methods of expression that they employ.

It is impossible here to give any summary or criticism of the work recorded. It must suffice to say that the authors have followed very much on the lines of the work of Messrs. Hurter and Driffield, confirming a great many of their inferences, but modifying a few, and that they have expanded these investigations somewhat in a few directions where they needed following up, because of developments that have taken place during the last twelve years or so. They have done much valuable work, and this convenient record of it will find a place on the bookshelves of all who are interested in the study of the principles that make photography possible.

PHYSICS.

Manual of Wireless Telegraphy, by A. F. Collins (New York: John Wiley and Sons; London: Chapman and Hall; 6s. 6d.).—This small work is distinguished from the larger treatises inasmuch as it is specially intended to provide a vade mecum for operators. Detailed and explicit instructions are given for wiring the various types of sending and receiving apparatus, for the adjustment of the instruments, timing and syntonizing the circuits, testing the devices, and, finally, for the management of ship and shore stations. From beginning to end this is done in a masterly manner. Lucid explanations are given of the theory connected with the transmission of signals; these are aided on nearly every page by excellent illustrations. The information which relates to special apparatus employed by the various companies has been obtained direct from them. The volume concludes with a list of the literature on the subject and a glossary. We recommend the book in every way to those who wish a practical acquaintance with wireless telegraphy.

THEOLOGY.

A Much-Abused Letter, by George Tyrell (London: Longmans and Co., 1906).—Though things theological scarcely come within the scope of the pages of "KNOWLEDGE," we have great pleasure in commending this book to the notice of such of our readers as are interested in the attitude of the Catholic Church towards men of science, and the exercise of private judgment. Signs are not wanting which show that a storm of unprecedented fury is brewing. Father Tyrell has had a foretaste of this fury, and he states the facts of the case with great spirit and fairness.

STANDARD METEOROLOGICAL INSTRUMENTS.—We have received from MESSRS. F. DARTON AND CO., 142, St. John Street, London, E.C., a copy of their "Illustrated Price List of Standard Meteorological and other Instruments." Apart from being a price list, this contains descriptive accounts of the various patterns of instruments, which are also illustrated by very clearly-drawn blocks. In addition to the ordinary and self-recording meteorological instruments for use in public and private observatories, the list contains descriptions of those suitable for ballooning and exploring expeditions. A useful list of books and publications on meteorology is also given.

BIRKBECK COLLEGE.—We have received a copy of the Calendar of this well-known Institution for the Session 1907-8. The Calendar includes full particulars of the Courses of Study for the Science, Arts, Commerce, and Law Degrees of the University of London, conducted by recognised teachers of the University; also of those for the examinations of the Conjoint Board, Pharmaceutical Society, Board of Education, etc. The laboratories are particularly well equipped for the practical work of the Science Courses.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page* 215.)

FOR opaque mounts it is customary to cover the bottom of the cell with some opaque medium, such as Brunswick black, or black paper, or both. The black back-ground should be dull. Suitable discs can be readily cut from dull black paper, such as is used for masks for lantern slides. The drawback to such a back-ground is that whilst it enhances the effect when the object is illuminated from above, it renders the use of a Lieberkühn or similar means of illumination from below impossible, and my own plan is to mount all dry objects without a black back-ground, and to have a slide or two carrying a disc of black paper to put below the opaque object when required. Of course, there is a slight amount of reflection from the slide.

Objects can be fastened in position with a little gum, which should not project beyond them. Very minute objects like pollen, &c., require a film of dilute gum on the back-ground, which is allowed to dry, and then just breathed on to moisten it when mounting. The gum can be kept from becoming too brittle by adding a few drops of glycerine per ounce, and it is well also to add one or two drops of carbolic or some essential oil, such as oil of cloves, to inhibit fungoid growths.

Finally, it is important to make sure that all cement or gum used is absolutely dry before the cover-glass is finally applied, or a fine dew will settle upon the cover-glass and spoil the mount.

I have thought it most convenient to begin with mounting methods and tacitly to assume that neither sectioning nor staining were required. However, the majority of objects require both, and I must now proceed to deal with these processes in their due order. It is scarcely necessary for me to do more than allude in passing to merely mechanical means of separation, such as teasing with fine needles, or to dissecting, or to chemical dissociation by maceration.

As stated at the outset, most objects are too thick and too opaque to give good results when examined microscopically, and, therefore, thin sections or slices are required. Some sections can, of course, be cut by hand, and a little practice and patience will soon give great facility in this respect. A good razor is the only essential, but it is important that it should be sharp and in perfect condition. Hollow-ground razors are of little use; the best razor is one of the old-fashioned heavy English type, and a very suitable one can be bought for about 2s. 6d. almost anywhere. The beginner finds most difficulty in keeping a good edge on his razor, and it is strange how often one sees the stropping done in just such a way as might be best calculated to destroy what edge there is on the razor, so a few words on the art of stropping may not come amiss. I would advise that the ordinary leather strop should be rigidly avoided. If it must be used it should be held quite taut. The best strops are those mounted upon handles, upon which the leather is carefully stretched to form a slightly convex surface from side to side. Such strops have, of course, one side of plain leather, and the other side covered with some kind of preparation. The latter should be used sparingly. The important points are to have the strop firmly supported at one end, either by a ring on a hook, or upon the table; to hold the strop firmly; to lay the razor flat upon the leather without any inclination whatsoever; to use moderate pressure; to strop the razor backwards; and, above all, to turn it at the end of each stroke on its *back* and not upon its edge. The turning of a razor upon its edge when stropping will ruin the best edge ever put upon it, and yet one frequently sees it done by inexperienced users. Moreover, it looks very easy when one sees a hairdresser stropping a razor with a few lightning turns of his wrist, but those of us who do not aspire to professional skill of this sort, born of constant practice, will be well advised to strop slowly, carefully, and steadily, remembering that in too many cases we are far more likely to damage than to improve the edge of our razors.

For actual section-cutting by hand the object is held between the forefinger and thumb in such a way that the palm of the hand lies towards the body, the fingers are bent round the object, and the tip of the thumb comes nearly horizontally against and slightly lower than the middle joint of the first finger, this middle joint itself lying quite horizontally. Thus the object requiring cutting is held between the tip of the thumb and the middle joint of the forefinger; the tip of the thumb is just below the level of the cut of the razor and so out of harm's way, whilst the middle joint of the forefinger forms a horizontal table to steady the razor in cutting. A dish of methylated spirit and water is kept close by, and into this the razor is constantly dipped so as to flush both it and the object, whilst the razor is drawn steadily and slowly with a slicing motion towards the operator. The sections as they are cut are floated off into a small dish of mixed spirit and water. With a little practice wonderfully thin and regular sections can be cut in this way from suitable objects. As a means of practice a piece of dry elder pith or a bit of the stem of a carrot can be recommended.

Better and more regular sections can, of course, be cut by means of the hand-microtomes, of which there are many patterns offered for sale. They generally consist of a flat, horizontal plate of brass or glass, perforated with a hole in the centre, with a tube attached at right angles to contain the object and to serve as a handle. The object is pushed through the hole and is fed as required by means of a large-headed screw beneath it. Many of these simple microtomes have graduated screws for this last adjustment so that the regularity of the thickness of the sections can be assured, and such thickness even calculated. Some are made to clamp on a table.

(*To be continued.*)

Collecting and Preserving Thysanura.

In a recent number of an American journal (*Ohio Naturalist*) Mr. A. D. Jackson gave an account of his methods of collecting and preserving Thysanura. The best way to collect them alive is to put two or three (not more) into capsules, each containing a small piece of tissue paper to absorb moisture and to give the insect something to crawl over. The capsules must be perforated with a fine pin-point to admit air, as the antennæ and body shrink if the insects die. Another method is to use a large-mouthed bottle with a funnel in the neck over which pieces of wood or bark can be tapped, and containing damp wood and leaves for the

animals to crawl over. For fixing the insects in the field small round phials filled with the fixative are required, as well as some fine camel-hair brushes, a large square of white oil-cloth, and a chisel for dislodging bark or decaying wood. The pieces of bark are pounded over the cloth on which the insects fall, and the brush moistened with fixative is placed over the insect, which, when stupefied, is easily removed to the bottle. The fixative is made of glacial acetic acid and absolute alcohol in equal proportions, and corrosive sublimate to saturation. This fixes in a few seconds, but specimens may be left on it for hours, and then transferred to 85 per cent. alcohol, or they can be placed on a covered dish and glycerine added at one side. After a time the cover is removed to allow the acetic acid and alcohol to evaporate. Specimens may be examined in cedar or clove oil which has been boiled down to a thick syrup. Thysanura is easily kept alive in a straight-necked bottle at the bottom of which are a few bits of decayed leaves and dirt. A piece of decayed wood is then gummed tightly in as a stopper, and kept moist. The bottle must be kept in a dark place, and the insects will do as well in the laboratory as in their natural surroundings.

Railway Microbes.

The *Daily Telegraph* of August 20 had an amusing paragraph with the above heading in good-sized capitals, which was telegraphed from their special correspondent in Paris. It purported to give an account of the dust in a first-class carriage on a Bordeaux train, which, having been "scientifically analysed," was found (according to the said correspondent) to contain the following germs—I quote verbatim and without altering the spelling:—"(1) The penicilium glaucum, which produces appendicitis; (2) Asperbillus niger, which affects the digestion; (3) the Bacterium Termo, or Proteus zuckeri, which generally weakens the human body; (4) the stapylococcus pyogenes aureus, which begets phlegmon; (5) Micrococcus tetragenos of tuberculosis; (6) Koch's bacillus of tuberculosis; (7) Klebsloffler's bacillus of diphtheria; (8) the coli bacillus, which produces typhoid; (9) the streptococcus lanceolatus niger, the microbe of pneumonia; and (10) and last, Legros' bacillus septicus, which inflicts gangrene." The writer observes that "the dust from other expresses to Marseilles, or Calais, or Basel, or elsewhere yield the same bacterial cultures," and goes on to draw the inevitable conclusion as to the danger run by railway travellers, adding: "Supposing you safely run the gauntlet of nine deadly species of bacteria, the insidious tenth, Dr. Legros' charmingly-named 'sceptical bacillus,' may finish you off. The sceptical microbe gives you gangrene, an affection about which there is no possible doubt." With the pseudo science of the halfpenny sensation-mongers we are unfortunately only too familiar, but one is wishful to believe that the *Daily Telegraph's* correspondent accepted and forwarded the above rigmarole in good faith, and is, therefore, to be sympathised with. To a medical man the list is a joyous one, and adds not a little to his store of knowledge.

Notes and Queries.

H. C. (Stafford).—The displaying of an object in a dry cell is merely a matter of arrangement, and should present no difficulties as the parts in most cases can easily be set in position with the help of a couple of needles and a low power lens. But I think it is more probable that the objects you refer to, the heads of insects, etc., are really mounted without pressure, in some transparent and practically invisible mounting medium. There are many such media, but perhaps the most commonly used are Canada balsam and glycerine. The insect or its part must first be soaked in caustic potash, a five or ten per cent. solution, according to the delicacy of the structures. It is impossible to give any data as to the time required. A hard chitinous object like a cock-roach may require a couple of days, and other objects much less, and the best guide is to watch the process carefully. The aim is to get the object soft and supple, and to dissolve the viscera, etc., without making the object rotten. The viscera are best got rid of by rolling with a couple of camel-hair pencils. The potash must then be thoroughly washed out with water, and the insect put for about twelve hours into acetic acid. The acid must in turn be washed away, and the object then transferred to methylated spirit, where it can lie for an indefinite time. It is important, however, to arrange the parts in the required position as soon as the insect is put into the spirit, the action of which will soon harden them. When it is desired to mount, the object can be taken out, drained a little, and then put to clear in turpentine, cedar-oil, clove oil, or some similar agent (see "KNOWLEDGE" for August last, page 190). All that is now necessary is to mount the object in Canada balsam in a cell of suitable depth, either an excavated cell, or one built up with a ring of glass, tin, vulcanite, etc. (see "KNOWLEDGE" for September last, page 214). It is necessary to make sure that there is sufficient Canada balsam to entirely fill the cell so that the air-bubbles may be avoided when the cover-glass is put on, and to ensure there being a thin film of contact all round. To mount in glycerine, the same soaking in potash is generally necessary, but the object must be mounted direct from the water used to wash out the acetic acid.

W. H. C. (Cradock, South Africa).—Have you tried grinding one side of the section perfectly smooth and level, and then cementing it to a glass slip with Canada balsam, before proceeding to polish the other side? This is the usual process, and with care is generally successful. The polishing powders can be used on fine flannel stretched on glass, and are mixed with filtered soap solution as medium to fix the powder on to the flannel.

E. V. B. F. (Kensington).—To kill the larger snails and slugs I would suggest your modifying your procedure by putting them into a jar of cold water, and then running a layer of hot water on to the surface of the cold water. The jar must be full to the very top and closed with a glass plate, and the cold water must have been boiled first and hermetically sealed. You might also try the effect of adding a little tobacco to the water. I have not tried either of these methods myself, so shall be interested in learning what your results may be. To take photographs of shells you will need a photo-micrographic camera, and one of the low-power planar lenses, with a focal length of 3 or 4 inches, such as those of Watson at £4 each. Zeiss's Micro-planars of equivalent magnification cost £6 each. The 4-inch would give a magnification of 2½ diameters at 10 inches distance. Reichert makes a very good projection objective of 4-inch focus at £3.

R. and J. Beck's New Catalogue.—I have received from Messrs. R. and J. Beck, a useful little 40-page catalogue of microscopic apparatus, containing many items of interest, some of which have been already described in these columns. Amongst comparative novelties, attention may be called to the Ashe-Finlayson Comparascope for making comparisons between two objects lying side by side; an object-marker which scratches with a diamond a fine circle upon the cover-glass around any required object; Cheshire's Apertometer; sundry apparatus, for holding objects; photo-micrographic apparatus, etc. Concerning one or two of these items, I shall hope to have more to say at an early date. The catalogue contains four pages of very practical hints on the use of the apparatus, but possesses an incidental draw-back in being priced at not less than 1s., though the makers offer to return this sum if purchases of not less than £1 be made.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

The Face of the Sky for October.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.0 and sets at 5.39; on the 31st he rises at 6.52 and sets at 4.35.

Sunspots and faculæ may frequently be observed on the solar disc; the granular structure of the surface can be particularly well seen on foggy mornings, as the atmosphere is quiet and the image steady. At the time of writing three conspicuous spots are observable on the disc.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Oct. 3 ..	26° 14′E	6° 35′	106° 46′
,, 8 ..	26° 25′E	6° 18′	40° 47′
,, 13 ..	26° 26′E	5° 58′	334° 50′
,, 18 ..	26° 16′E	5° 35′	268° 52′
,, 23 ..	25° 53′E	5° 10′	202° 56′
,, 28 ..	25° 20′E	4° 43′	136° 59′
Nov. 2 ..	24° 34′E	4° 13′	71° 4′

THE MOON:—

Date.	Phases.	H. M.
Oct. 7 ..	● New Moon	10 21 a.m.
,, 14 ..	☽ First Quarter	10 2 a.m.
,, 21 ..	○ Full Moon	9 17 a.m.
,, 29 ..	☾ Last Quarter	7 52 a.m.
,, 14 ..	Perigee	2 18 p.m.
,, 28 ..	Apogee	9 12 a.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
Oct. 13	B.A.C. 6448	5·9	8.14	108°	9.15	240°
,, 24	*i* Tauri	5·1	9.16	81°	10.18	244°
,, 27	63 Geminorum ..	5·3	10.10	81°	11. 7	272°

THE PLANETS.—Mercury (Oct. 1, R.A. $13^h\ 30^m$; Dec. S. 10° 13′. Oct. 31, R.A. $15^h\ 44^m$; Dec. S. 22° 45′) is an evening star in Virgo and Libra. The planet is at greatest easterly elongation of 24° 20′ on the 23rd, when he sets at 5.23 p.m., or 32 minutes after the Sun, thus the elongation is not a favourable one.

Venus (Oct. 1, R.A. $12^h\ 44^m$; Dec. S. 3° 27′. Oct. 31, R.A. $15^h\ 6^m$; Dec. S. 17° 14′) is an evening star in Virgo and Libra during the earlier and latter part of the month respectively. The planet is not well placed for observation as she sets only about half an hour after the Sun; on the evening of the 27th she appears in close proximity to the star α Libræ. As seen in the telescope the disc appears gibbous, ·99 being illuminated, with a diameter of 10″.

Mars (Oct. 1, R.A. $19^h\ 43^m$; Dec. S. 24° 47′. Oct. 31, R.A. $20^h\ 56^m$; Dec. S. 19° 40′) is due South about 7 p.m., when he may be observed shining as a bright reddish star. The planet, however, appears only about one-quarter as bright as at opposition in consequence of increased distance from the earth, the apparent diameter having diminished to about 11″.

Jupiter (Oct. 1, R.A. $8^h\ 43^m$; Dec. N. 18° 36′. Oct. 31, R.A. $8^h\ 59^m$; Dec. N. 17° 38′) is coming into a more favourable position for observation, rising at 12.24 a.m. on the 1st, and at 10.43 p.m. on the 31st. The planet is situated in Cancer, and appears in the sky to the S.E. of Castor and Pollux, forming an obtuse angled triangle with these bright stars. The planet, however, is the most conspicuous object in the S.E. portion of the sky during the early morning hours.

Saturn (Oct. 1, R.A. $23^h\ 38^m$; Dec. S. 5° 1′. Oct. 31, R.A. $23^h\ 31^m$; Dec. S. 5° 41′) is very favourably placed for observation, being due South on the 15th at 10 p.m. The planet is the most conspicuous object in the sky looking South about 10 p.m., when he may be observed shining as a bright star without scintillation, but with a peculiar lustre which has given it the name of the leaden planet. The outer major and minor axes of the ring system are respectively 44″ and 0″·4, so that in small telescopes the ring presents the interesting appearance of being closed; the diameter of the ball is 18″. On the evening of the 18th, the planet appears 2° North of the Moon at 6 p.m.

Uranus (Oct. 15, R.A. $18^h\ 39^m$; Dec. S. 23° 30′), remains in Sagittarius, but is not very favourably situated for observation, being low down and setting soon after 10 p.m. at the beginning of the month, and at 8 p.m. at the end of the month.

Neptune (Oct. 15, R.A. $7^h\ 4^m$; Dec. N. 21° 47′) rises shortly after 9.30 p.m. and crosses the meridian at 5.29 a.m. at the middle of the month. The planet is about 1½° North-West of ζ Geminorum, is in quadrature on the 3rd, and stationary on the 19th.

METEORS.—The principal meteor showers during the month is that having its radiant point near ν Orionis, and hence known as the Orionids. The maximum is from the 18th to the 20th, and the meteors are described as swift with streaks. The radiant point is in R.A. $6^h\ 8^m$, Dec. N. 15°.

Algol presents conveniently observable minima on the 5th, at 9.47 p.m.; 8th, at 6.36 p.m.; 25th, at 11.30 p.m.; 28th, at 8.18 p.m.; and 31st, at 5.7 p.m.

TELESCOPIC OBJECTS:—

Double Stars.—γ Arietis $1^h\ 48^m$, N. 18° 48′, mags. 4·2, 4·4; separation, 8″·8. Easy double, power 30; notable as being the first double star observed telescopically.

γ Andromedæ $1^h\ 58^m$, N. 41° 51′, mags. 2·1, 4·9; separation 10″·2. The brighter component is intensely yellow, whilst the other is greenish blue. The fainter star is remarkable for being a binary, the components of which are now less than 1″ apart.

NEBULÆ.—Nebula in Andromeda, easily visible to the naked eye, and readily found by referring to the stars β and ν Andromedæ. Seen with a three or four inch telescope, it appears to be an extended oval, which is in reality composed of spiral streams of nebulous matter.

(32 M.) Nebula close to the great Andromeda nebula, and situated about 2° to the South. It is fairly round, and appears somewhat like a star out of focus.

(18 ℍ) lies about the same distance North of the great Andromeda nebula that 32 M does South; it is faint, but large and elliptical.

XUM